NAVY
SBIR FY04.1 PROPOSAL SUBMISSION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper, (703) 696-8528. The Deputy SBIR Program Manager is Mr. John Williams, (703) 696-0342. For technical questions about the topic, contact the Topic Authors listed under each topic on the website before **1 December 2003.** For general inquiries or problems with the electronic submission, contact the DoD Help Desk at 1-866-724-7457 (8AM to 5PM EST).

The Navy's SBIR program is a mission-oriented program that integrates the needs and requirements of the Navy's Fleet through R&D topics that have dual-use potential, but primarily address the needs of the Navy. Information on the Navy SBIR Program can be found on the Navy SBIR website at **http://www.onr.navy.mil/sbir**. Additional information pertaining to the Department of the Navy's mission can be obtained by viewing the website at **http://www.navy.mil**.

PHASE I PROPOSAL SUBMISSION:

Read the DoD Program Solicitation at www.dodsbir.net/solicitation for detailed instructions on proposal format and program requirements. When you prepare your proposal, keep in mind that Phase I should address the feasibility of a solution to the topic. The Navy only accepts Phase I proposals with a base effort not exceeding $70,000 and with the option not exceeding $30,000. The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I option should address the transition into the Phase II effort. Phase I options are typically only funded after the decision to fund the Phase II has been made. Phase I proposals, including the option, have a 25-page limit (see section 3.3). The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in section 4.0 of the program solicitation. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded. The Navy typically provides a firm fixed price contract or awards a small purchase agreement as a Phase I award.

ALL PROPOSAL SUBMISSIONS TO THE NAVY SBIR PROGRAM MUST BE SUBMITTED ELECTRONICALLY

It is mandatory that the **entire** technical proposal, DoD Proposal Cover Sheet, Cost Proposal, and the Company Commercialization Report are submitted electronically through the DoD SBIR website at **http://www.dodsbir.net/submission**. If you have any questions or problems with the electronic submission contact the DoD SBIR Helpdesk at 1-866-724-7457 (8AM to 5PM EST).

Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents is submitted separately through the website. Your proposal must be submitted via the submission site on or before the **6:00 a.m. EST, 15 January 2004** deadline. A hardcopy will NOT be required. A signature by hand or electronically is not required when you submit your proposal over the Internet.

Acceptable Formats for Online Submission: All technical proposal files will be converted to Portable Document Format (PDF) for evaluation purposes – do not lock/protect your pdf file. The Technical Proposal should include all graphics and attachments, but not include Cover Sheets. You are required to include your company name, proposal number and topic number as a header in your technical proposal document. Cost sheets can be included in the technical proposal or submitted separately through the form available through the Submission website. Technical Proposals should conform to the limitations on margins and number of pages specified in the the DoD Program Solicitation. However, your on-line Cost Proposal will only count as one page and your Cover Sheets will only count as two, no matter how they print out after being converted. Most proposals will be printed out on black and white printers so make sure all graphics are distinguishable in black and white. It is strongly encouraged that you perform a virus check on each file you upload. If a virus is detected, the file will be deleted. To verify that your proposal has been received, click on the "Check Upload" icon to view your proposal. Typically, your proposal will be virus checked and converted within the hour. However, if your proposal does not appear after an hour, please contact the DoD Help Desk. It is recommended that you submit early, as computer traffic gets heavy nearer the solicitation closing and slows down the system.

Within one week of the Solicitation closing, you will receive notification via e-mail that your proposal has been received and processed for evaluation by the Navy. Please make sure that your e-mail address is entered correctly on your proposal coversheet or you will not receive a notification.

PHASE I ELECTRONIC FINAL REPORT:

All Phase I award winners must electronically submit a Phase I summary report through the Navy SBIR website at the end of their Phase I contract. The Phase I Summary Report is a non-proprietary summary of Phase I results. It should not exceed 700 words and should include potential applications and benefits. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR website at: **http://www.onr.navy.mil/sbir**, click on "Submission", then click on "Submit a Phase I or II Summary Report".

ADDITIONAL NOTES:

The Small Business Administration (SBA) has made a determination that will permit the Naval Academy, the Navy Post Graduate School and the other military academies to participate as subcontractors in the SBIR/STTR program, since they are institutions of higher learning.

The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir**. A Navy success story is any follow-on funding that a firm has received based on technology developed from a Navy SBIR or STTR Phase II award. The success stories should be included as appendices to the proposal. These pages will not be counted towards the 25-page limit. The success story information will be used as part of the evaluation of the third criteria, Commercial Potential (listed in Section 4.2 of this solicitation) which includes the Company's Commercialization Report and the strategy described to commercialize the technology discussed in the proposal. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DoD programs and/or weapon systems. If a firm has never received a Navy SBIR Phase II it will not count against them. Phase III efforts should also be reported to the Navy SBIR program office noted above.

NAVY FAST TRACK DATES AND REQUIREMENTS:

The Fast Track application must be received by the Navy 150 days from the Phase I award start date. Your Phase II Proposal must be submitted within 180 days of the Phase I award start date. Any Fast Track applications or proposals not meeting these dates may be declined. All Fast Track applications and required information must be sent to the Navy SBIR Program Manager at the address listed above, to the designated Contracting Officer's Technical Monitor (the Technical Point of Contact (TPOC)) for the contract, and the appropriate Navy Activity SBIR Program Manager listed in Table 1 of this Introduction. The information required by the Navy, is the same as the information required under the DoD Fast Track described in the front part of this solicitation.

PHASE II PROPOSAL SUBMISSION:

Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which achieved success in Phase I, as determined by the Navy Activity point of contact (POC) measuring the results achieved against the criteria contained in section 4.3, will be invited to submit a Phase II proposal by that Activity's proper point of contact, listed in Table 1. During or at the end of the Phase I effort awardees will be notified to participate for evaluation of their proposal for a Phase II award. The invitation will be based on the success to which the company has accomplished for the particular topic as evaluated by the monitoring activity/command. If you have been invited to submit a Phase II proposal to the Navy, obtain a copy of the Phase II instructions from the Navy SBIR website or request the instructions from the Navy Activity POC listed in Table 1. The Navy will also offer a "Fast Track" into Phase II to those companies that successfully obtain third party cash partnership funds ("Fast Track" is described in Section 4.5 of the program solicitation). The Navy typically provides a cost plus fixed fee contract or an Other Transition Agreement (OTA) as a Phase II award. The type of award is at the discretion of the contracting officer.

Upon receiving an invitation, submission of a Phase II proposal should consist of three elements: 1) A base effort, which is the demonstration phase of the SBIR project; 2) A separate 2 to 5 page Transition/Marketing plan (formerly called a "commercialization plan") describing how, to whom and at what stage you will market and transition your technology to the government, government prime contractor, and/or private sector; and 3) At least one Phase II Option which would be a fully costed and well defined section describing a test and evaluation plan or further R&D. Phase II efforts are typically two (2) years and Phase II options are typically an additional six (6) months. **Each of the Navy Activities have different award amounts and schedules; you are required to visit the website cited in the invitation letter to get specific guidance for that Navy Activity before submitting your Phase II proposal**. Phase II proposals together with the Phase II Option are limited to 40 pages (unless otherwise directed by the TPOC or contract officer). The Transition/Marketing plan must be a separate document that is submitted through the Navy SBIR website at **http://www.onr.navy.mil/sbir** under "Submission" and also included with the proposal submission online. All Phase II proposals must have a complete electronic submission. Complete electronic submission includes the submission of the Cover Sheets, Cost Proposal, Company Commercialization Report, the **ENTIRE** technical proposal and any appendices via the DoD Submission site. The DoD proposal submission site **http://www.dodsbir.net/submission** will lead you through the process for submitting your technical proposal and all of the sections electronically. Each of these documents are submitted separately through the website. Your proposal must be submitted via the submission site on or before the Navy Activity specified deadline.
All Phase II award winners must attend a one-day Commercialization Assistance Program (CAP) meeting typically held in the July to August time frame in the Washington D.C. area during the second year of the Phase II effort. If you receive a Phase II award, you will be contacted with more information regarding this program or you can visit **http://www.navysbir.com/cap**. Recommend budgeting at least one trip to Washington in your Phase II cost proposal.

As with the Phase I award, Phase II award winners must electronically submit a Phase II summary report through the Navy SBIR website at the end of their Phase II. The Phase II Summary Report is a non-proprietary summary of Phase II results. It should not exceed 700 words and should include potential applications and benefit. It should require minimal work from the contractor because most of this information is required in the final report.

Effective in Fiscal Year 2000, a Navy Activity will not issue a Navy SBIR Phase II award to a company when the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by a no cost extension beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

PHASE II ENHANCEMENT

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that the company obtains from an acquisition program. Up to $250,000 in additional SBIR funds for $1,000,000 match of acquisition program funding, can be provided as long as the Phase III is awarded and funded during the Phase II. If you have questions, please contact the Navy Activity POC.

PHASE III

Public Law 106-554 provided for protection of SBIR data rights under SBIR Phase III awards. A Phase III SBIR award is any contract or grant where the technology is the same as, derived from, or evolved from a Phase I or a Phase II SBIR/STTR contract and awarded to the company which was awarded the Phase I/II SBIR. This covers any contract/grant issued as a follow-on Phase III SBIR award or any contract/grant award issued as a result of a competitive process where the awardee was an SBIR firm that developed the technology as a result of a Phase I or Phase II SBIR. The Navy **will** give SBIR Phase III status to any award that falls within the above-mentioned description. The government's prime contractors and/or their subcontractors will follow the same guidelines as above and ensure that companies operating on behalf of the Navy protect data rights of the SBIR company.

TABLE 1. NAVY ACTIVITY SBIR PROGRAM MANAGERS POINTS OF CONTACT (POC) FOR TOPICS

Topic Numbers	Point of Contact	Activity	Phone
N04-001 thru N04-029	Mrs. Carol Van Wyk	NAVAIR	301-342-0197
N04-030 thru N04-032	Mr. Nick Olah	NAVFAC	805-982-1089
N04-033 thru N04-101	Mrs. Janet Jaensch	NAVSEA	202-781-3728
N04-102 thru N04-104	Mr. Ron Vermillion	ONR1	540-653-8906
N04-105 thru N04-144	Ms. Cathy Nodgaard	ONR2	703-696-0289
N04-145 thru N04-150	Ms. Linda Whittington	SPAWAR	858-537-0146
N04-151 thru N04-152	Mr. Dave Dugan	SSP	202-764-1554

For general program and administrative questions, please contact the Program Managers above; do not contact them for technical questions. For technical questions, please contact the topic authors during the pre-solicitation period from 1 October until 1 December 2003. These topic authors are listed on the Navy website under "Solicitation" or the DoD website. Beginning 1 December, you must use the SITIS system listed in section 1.5c of the program solicitation to receive answers to technical questions

PHASE I PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria <u>must be met</u> or your proposal will be REJECTED.

____1. Make sure you have added a header with company name, proposal number and topic number to each page of your technical proposal.

____2. Your technical proposal has been uploaded. The DoD Proposal Cover Sheet, the DoD Company Commercialization Report, and the Cost Proposal have been submitted electronically through the DoD submission site by 6:00 a.m. EST 15 January 2004.

____3. After uploading your file and it is saved on the DoD submission site as a PDF file, review it to ensure that it appears correctly.

____4. The Phase I proposed cost for the base effort does not exceed $70,000. The Phase I Option proposed cost does not exceed $30,000. The costs for the base and option are clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

NAVY 04.1 Topic List

NAVAIR

N04-001	Chrome-Free Room Temperature Curing Fuel Tank Coating
N04-002	Fiber Optic Splice
N04-003	Ruggedized Laser Diode Package for Wavelength Division Multiplexed (WDM) Networks
N04-004	Advanced Radiating Apertures for Reduced Signature Platforms
N04-005	Small Multi-Decade Communication Antenna
N04-006	Noncooperative Tracking of Underwater Vehicle
N04-007	Continuous Active Sonar (CAS)
N04-008	Improved Crashworthy Seating for Naval Helicopters
N04-009	Military Gas Turbine Engine High-Cycle Fatigue (HCF) Mitigation
N04-010	Self-Evolving Maintenance Knowledge Bases
N04-011	Next Generation Data Fusion Architecture
N04-012	Ceramic Hybrid Bearing Fault Detection
N04-013	High-Speed Machining of Thin-Web, Large-Pocket Ti-6Al-4V Firewalls/Bulkheads
N04-014	Low-Observable Remote Sensor Deployment
N04-015	Multi-Source Vertical Obstruction Generation
N04-016	Intelligent Aircraft/Ship Data Analysis Options
N04-017	Low Coefficient of Friction Gear Coating
N04-018	Design and Life Prediction Methodologies for Weight Efficient Ceramic Matrix Composite (CMC) Propulsion Components
N04-019	Damping Coatings for Gas Turbine Compression System Airfoils
N04-020	Innovative Materials and Designs for Joint Strike Fighter Lift Fan Drive Shaft
N04-021	Development of Gas Turbine Augmentor Testing Procedures
N04-022	Airborne and Air-Deployed Multi-Sensor Search Optimization
N04-023	Repair Process for Ion Vapor Deposition (IVD) Aluminum
N04-024	Strong Location-Specific Authentication for Mobile Users and Devices
N04-025	Laser Repair of Compressor Blades
N04-026	Aircraft Carrier Catapult Cylinder Slot Gap Measurement
N04-027	A Fidelity Analysis Tool for F-35 Joint Strike Fighter Training Systems
N04-028	Modeling, Simulation, and Other Techniques to Verify and Validate Prognostic and Health Maintenance (PHM) Capabilities
N04-029	Assessing Useful Remaining Life of Lithium (Li)-Ion Batteries After Deep Discharges

NAVFAC

N04-030	New High Temperature Pavement Joint Sealants
N04-031	Heat Recovery System for Discharged Hot Water into the Sewer System
N04-032	New Non-Silicone Airfield Joint Sealant for General Use

NAVSEA

N04-033	Mixing Techniques for Diverse Control Effectors
N04-034	Depth Control System for Fatline Towed Arrays
N04-035	High Strength, Lightweight Lifting Device
N04-036	High Fidelity Data Management and Access
N04-037	New Approaches for Reducing Helmholtz Resonance in Submarine Structures.
N04-038	Broad Band Acoustic Modeling of Reverberation for Torpedo Simulators
N04-039	Parametric Sonar to Enhance Torpedo Performance
N04-040	Electric Direct-Drive Actuator for the Universal Modular Mast
N04-041	Advanced Shipboard Electrical Control and Monitoring
N04-042	Lightweight Shipboard Inclined Ladder
N04-043	High Charge per Bunch Photocathode
N04-044	Airdroppable High Speed, Low Signature Craft
N04-045	Bore Insulator Materials for a Naval Electromagnetic Launcher
N04-046	~~MW Class Near Infrared Optics~~ Topic N04-046 has been cancelled. See topic N04-101
N04-047	Fiber optic power meter with optical detector in a detachable probe.

N04-048	Low Magnetic Signature, Rechargeable, Modular Battery Technologies for Mine Warfare
N04-049	Air-cooled High-power Blue-Green Laser
N04-050	Advanced Submarine Compatible Electric Power Source for Miniaturized Mine-Neutralization Vehicle Power
N04-051	Advanced Forward Looking Sonar for Unmanned Vehicles
N04-052	Expendable Array Installation System
N04-053	Advanced Pressure-Tolerant UUV Batteries for Fleet Use
N04-054	Multiple Secure Level Simulation Federation Technology
N04-055	Electromagnetic Susceptibility Threshold Distributions Tools for Electronic Systems
N04-056	Alternatives to Thermal Battery Power Supply for Missiles
N04-057	High Power Phase Shifters
N04-058	MMIC Coatings and Encapsulation for Non-Hermetic, Low Cost, Transmit/Receive Modules with the Reliability of Hermetic Packaging
N04-059	Exoatmospheric Attitude Control System For Very Long Range Projectiles
N04-060	Low Cost Modular Control and Actuation Systems
N04-061	Guidance Laws for Reduced Seeker Field of View Requirements
N04-062	Electronic Warfare (EW) Systems Antenna Enclosure concepts
N04-063	Undersea Small Object Avoidance
N04-064	Automated Situational Awareness Technology for Collision Avoidance
N04-065	In-Harbor/At-Sea Ship Defense
N04-066	Submarine Tactical Control Mission Planning
N04-067	Syntax Independent Models in XML for Software Structure Analysis.
N04-068	Communication Analysis System for Intrusion Detection Systems (IDSs)
N04-069	Analytical tool sets with models, metrics, and measurement techniques for System Architecture development.
N04-070	Compact Variable Depth Sonar (CVDS)
N04-071	Surface Ship, Hull Mounted, Mine Avoidance Sonar
N04-072	Exploitable Features for Target Classification in High Frequency Mine Avoidance Sonars
N04-073	Bulkhead Shaft Sealing Device for Damage Control
N04-074	Advanced Deck Covering Materials
N04-075	Electromagnetic Pulse Protection For Distributed, Shipboard Transducer-bus Networks
N04-076	Wireless LAN Emissions Attenuation Technologies
N04-077	Automated Highline/ Spanwire Engagement
N04-078	UAV based Network-Centric Communications for Sensors
N04-079	Control/Diagnostic/Maintenance System for High Speed, High Output Diesel Engines
N04-080	High Energy Density Power Sources for Unmanned Surface Vehicle (USV) Sensor Payloads
N04-081	Shipboard Lighting System
N04-082	Blast Protection and Damage Mitigation Coatings
N04-083	Standoff Weapons-Barrier System
N04-084	De-icing Systems for Shipboard Composite Structures
N04-085	Lightweight Passive Fire Protection System for Composite Structures
N04-086	Integrated Bridge Sonar Interface and Object Avoidance
N04-087	Automated Asset Deployment and Retrieval System from Organic Offboard Vehicles (OOVs)
N04-088	Configuration Management and Monitoring System for Mission Module Interfaces
N04-089	Improved Optics for Overhead Flood Lights
N04-090	Advanced Structural Development for Naval Hovercraft Ramps
N04-091	Advanced Structural Development for the Personnel Transport Module (PTM)
N04-092	Unmanned Vehicle (UV) to Stern Ramp Launch and Recovery Interface
N04-093	Structurally Efficient, Low-Cost Joining Techniques
N04-094	Vinyl Ester Compatible, High Modulus Fiber System for Composite Laminates
N04-095	High Temperature, High Power Density Electronic Devices
N04-096	RF Power Scavenging for Wireless Sensors
N04-097	Conversion of Friable Asbestos Containing Materials into Non-hazardous Substances
N04-098	Bio-Remediation of Hydrocarbons on Inactive Ships
N04-099	Explosive Cutting Technologies Applied to Ship Dismantling

N04-100	Automated Polychlorinated Biphenyl (PCB) Analyzer for Solid Waste Material
N04-101	MW Class Near Infrared Optics

ONR1

N04-102	Undersea Cable Power Distribution Scheme
N04-103	Advanced Antenna Integration Techniques
~~N04-104~~	~~Advanced Waveform Synthesis for Active Sensors~~ TOPIC CANCELLED

ONR2

N04-105	Scalability analysis of autonomous intelligent networked systems
N04-106	Wide-Area Beam Steering for Simultaneous Laser Designation of Multiple Targets
N04-107	Real-time Multisensor Tracking and Correlation of Surface Targets
N04-108	MIMO Techniques for LPI/LPD/AJ communications in highly mobile networks
N04-109	MIMO-OFDM based communications for Autonomous Highly Mobile Networks
N04-110	High Density Polymers for Reinforced High Density Reactive Materials
N04-111	Synthesis of Energetic PrePolymers of Varying BAMO and NMMO or PGN Content and Structure
N04-112	Sub-Pixel Super-Resolution ATR
N04-113	Optimization Techniques for High Performance Vacuum Electronic Devices
N04-114	Thermal Management Leads
N04-115	Adaptive, Intelligent Acoustic Recognition/Alert Systems for Security Breaching Noise Detection, Close Proximity Danger Identification, and Perimeter Protection
N04-116	Cross-Cultural Tactical Decision-Making in Coalition Operations
N04-117	Marine Mammal Vaccines
N04-118	Agent-based Simulation of Shipboard Manpower & Personnel (M&P) Behaviors
N04-119	Automated Communication Analysis for Interactive Situation Awareness Assessment
N04-120	Portable, lightweight, amalgamated thin-film photovoltaic/battery combination
N04-121	Large-Scale Batch Manufacture of Solid Polymer Electrolytes for High Energy and Power Density Rechargeable Li and Li-Ion Batteries
N04-122	Microbubble Injector and Measurement System
N04-123	Quiet, Efficient, High Power-Density Integrated Motor/Propulsor (IMP) and Controller
N04-124	Joining Methodologies for Titanium Alloys
N04-125	High Power Density and Thermally Stable Capacitors for Power Electronics Applications
N04-126	Dynamical Control of a Thermal Pulse Combustor
N04-127	Automated Launch and Recovery of Un-tethered, Mini-Unmanned Underwater Vehicles from Unmanned Surface Vehicles
N04-128	Unmanned Surface Vehicle Autonomous Maritime Seaway Navigation
N04-129	Near-Wall Turbulence and Skin Friction Measurements
N04-130	Advanced Portable Multi-Laser Processing System.
N04-131	Detectability of Low Radar Cross-Section (RCS) Targets at Sea
N04-132	Energy Finite Element Analysis System
N04-133	Infrared/Electro-Optic Detectability of Small Targets at Sea
N04-134	Recovery Algorithms for Ship Survivability
N04-135	Nano-Catalytic Combustion for Compact High-Thrust to Weight Ratio Propulsion Systems
N04-136	Adaptive Control of High-Speed Supercavitating Bodies
N04-137	Probabilistic Error Estimation In Model-Based Predictions
N04-138	Real-time Data Fusion and Visualization Interface for Environmental Research Data.
N04-139	An aircraft instrument for measurement of absorption at multiple wavelengths in the atmosphere.
N04-140	Advanced Oil Viscosity Measurement Technique
N04-141	Sensors and Techniques for Networked Autonomous Oceanographic Systems
N04-142	Technology for Shipbuilding Affordability
N04-143	Close Range Imaging Sensor for UCAV
N04-144	Thermal Imaging of the Head for the Sensing and Identification of Concealed Intent

SPAWAR

N04-145	Deployable Micro Weather Sensor

N04-146 Dynamically Configurable Antenna
N04-147 Tactical Secure Voice/Data Encryption Device
N04-148 RF Solution to Narrow In-Band Interference in UHF SATCOM Channels
N04-149 Command and Control Communications System Denial
N04-150 Radio Room RF Integrated Switching Matrix

SSP

N04-151 Development of Advanced Thermal Protection Concepts for Extended Flight/Maneuvering Navy Strategic Reentry Bodies
N04-152 Nuclear Event Detection and Circumvention Controller

Navy 04.1 Topic Descriptions

N04-001 TITLE: Chrome-Free Room Temperature Curing Fuel Tank Coating

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop an alternative, room temperature cured, non-chromated fuel tank coating that meets the requirements of Society of Automotive Engineers (SAE) AMS-C-27725.

DESCRIPTION: SAE AMS-C-27725 fuel tank coating is a proven technology for inhibiting corrosion and microbial growth in aircraft structures that are in contact with jet fuel. Defined specific material properties listed in the referenced specification pertain to corrosion protection, adhesion, microbial growth inhibition, and fluid resistance. Hexavalent chromium, an ingredient in SAE AMS-C-27725 materials, is an Environmental Protection Agency (EPA) toxic material and is a significant occupational health concern, including a proposed reduction in the permissible exposure limit by the Occupational Safety and Health Administration (OSHA). Additionally, elevated heat curing of some currently approved fuel tank coatings increases manufacturing costs and is not feasible for field level repair. The use of currently approved chromated and/or heat cured fuel tank coatings is financially and logistically cumbersome, affecting the aircraft throughout the entire lifecycle.

The Navy is seeking a new coating that meets the current performance requirements and is compatible with other aircraft system materials. The application of the coating should not interfere with logistical and operational requirements of the manufacturer or potential Fleet level users. The material should be capable of being cured at room temperature and applied with either high-volume low-pressure spray equipment or a brush. The candidate coatings must demonstrate compatibility with SAE-AMS-3277 and SAE-AMS-3281 fuel tank sealants when compared to the baseline fuel tank coating. The candidate coating must also demonstrate adhesion to graphite/epoxy composites and be able to conform to geometries consistent with fastener rows.

PHASE I: Identify and develop innovative material(s) to meet fuel tank coating requirements and demonstrate the feasibility of meeting the requirements of AMS-C-27725 and the requirements listed above.

PHASE II: Develop, test, and demonstrate the characteristics of the proposed materials to meet or exceed the requirements of AMS-C-27725. Validate material compatibility with the JSF fuel tank system.

PHASE III: Transition to the Fleet via specification modifications and revisions to aircraft weapon system technical manuals. Resolve any logistical constraints that may negatively affect program schedules.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial manufacturing or repair facilities could realize significant cost savings by utilizing less environmentally restrictive fuel tank coatings.

REFERENCES:

1. SAE AMS-C-27725, Coatings, Corrosion Preventive, Polyurethane for Use to 250° F (121° C).
2. SAE AMS-3277, Sealing Compound, Polythioether Rubber Fuel Resistant, Fast Curing Intermittent Use to 360°F (182°C)
3. SAE AMS-3281, Sealing Compound, Polysulfide Synthetic Rubber for Integral Fuel Tank and Fuel Cell Cavities, Low Density (1.20 to 1.35 specific gravity, for Intermittent Use to 360°F (182°C)
4. OSHA Request for Information, Occupational Exposure to Hexavalent Chromium (CrVI). Federal Register, Vol. 67, No. 163, 22 August 02.

KEYWORDS: Chrome; Heat-Cure; Room Temperature; Fuel Tank; Coatings; Materials

N04-002 TITLE: Fiber Optic Splice

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F/A-18, A6/EA-6

OBJECTIVE: Develop ruggedized optical fiber splice concepts and splice fabrication/assembly processes for splices capable of reliable operation in military/aerospace avionics fiber-optic network environments.

DESCRIPTION: The commercial sector telecommunication and data communication industries have developed a variety of fiber-optic technologies for splicing optical fibers in terrestrial and undersea fiber-optic cable systems. For example, mechanical splices have been developed to achieve low optical loss (< 0.5 dB) in commercial multimode fiber-optic cable plants. Fusion splicing technology has gained widespread use to achieve reduced optical splice loss, particularly in single-mode telecommunication fiber-optic systems.

Space intrusion limitations combined with equipment induced spark hazards and difficulties associated with high-temperature fiber coating removal currently preclude using fusion splice technology for on-aircraft repair of broken fiber-optic cables. Although mechanical splicing offers an alternative to fusion splicing, current mechanical splice designs based on fiber cleaving, fiber-to-fiber alignment, and index matching gel have not been developed for avionic environments. Military avionic fiber-optic cable plants operate over temperatures ranging from the extreme –75 to +200 °C range to a narrower range of –40 to +120 °C.

PHASE I: Develop splice design concepts and assembly hardware concepts that stretch the state-of-the-art for achieving low optical loss (< 0.5 dB is desired) splicing of single-mode and multimode optical fibers. Particular emphasis should be on applications where space intrusion limitations and environmental factors (wide temperature range, humidity, fluids, altitude immersion, etc.) preclude usage of commercial fiber-optic splicing technology for on-aircraft splicing of optical fiber.

PHASE II: Demonstrate fiber-optic splice hardware prototypes and fiber-optic splice assembly equipment prototypes. Test fiber-optic splice hardware prototypes for optical performance upon exposure to typical avionics qualification environmental stresses including repeated temperature cycling, altitude immersion, humidity, fluids, etc.

PHASE III: Coordinate with the Navy, standards organizations, and military/aerospace contractors and suppliers to productize the fiber-optic splice and associated splice assembly hardware. Incorporate new fiber-optic splice in repair kits for use in avionics systems utilizing fiber-optic interconnects.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private sector applications include computer and telecommunication networks incorporating fiber optic interconnects. The primary commercial beneficiary of this technology development will be the fiber-optics industry.

REFERENCES:
1. Miller, C.M. "Mechanical Optical Fiber Splices." J. Lightwave Tech., Vol. LT-4, No. 8, 1986.
2. Katagiri, T., et. al. "Basic Design for Highly Stable Mechanical Optical Fiber Splice and its Development." J. Lightwave Tech., Vol. 17, No. 1, 1999.
3. Yu, Q., et. al. "Refractive-Index Profile Influences on Mode Coupling Effects at Optical Fiber Splices and Connectors." J. Lightwave Tech., Vol. 11, No. 8, 1993.

KEYWORDS: Fiber-Optics; Repair; Splicing; Avionics; Fiber Cleaving; Fusion Splicing

N04-003 TITLE: Ruggedized Laser Diode Package for Wavelength Division Multiplexed (WDM) Networks

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: F/A-18, A6/EA-6

OBJECTIVE: Demonstrate a single-mode and multimode fiber pigtailed wavelength selected laser diode transmitter and a tunable laser diode transmitter, both suitable for operation in digital and analog military/aerospace avionic

WDM network environments. Investigate and validate low-profile (at least 32 output wavelengths for tunable) WDM transmitter packaging approaches (i.e., < 0.140” package height) with state-of-the-art or better operation at data rates > 10 Gb/s digital or up to 20 GHz analog at package case temperatures ranging between –40 and +85 °C or greater.

DESCRIPTION: Typical commercial sector opto-electronic packaging solutions based on in-package thermoelectric cooling of continuous wave (CW) or directly modulated tunable or fixed wavelength laser diodes with monolithically or hybridly integrated modulators, or external modulators, are not designed for operation in military avionic environments. Specific military form factor requirements differ in design complexity and degree of ruggedization relative to commercial parts. Typical military avionic opto-electronic modules are required to operate over a range of –40 to +85 °C for up to 15,000 hours. Modeling and simulation are encouraged to guide the development of thermoelectric cooled packaging approaches that meet or exceed typical avionic operational requirements.

PHASE I: Develop a proof-of-concept tunable and fixed wavelength laser diode optical subassembly (> 32 wavelengths for tunable) with monolithic or hybridly integrated internal modulator, or external modulator design, capable of interfacing with single-mode and multimode fibers. Develop an initial design concept and model key elements related to optical subassembly and modulator output wavelength, output power stability, waveform stability, bandwidth, power efficiency, and wide temperature range operation. Application of compact thermoelectric cooling solutions to achieve a low-profile optical subassembly design is encouraged. Monolithic, hybridly integrated, or external modulator components should be addressed in the overall proof-of-concept wide temperature range digital or analog transmitter designs.

PHASE II: Develop, demonstrate, and test a wavelength selected or tunable laser diode package with monolithic, hybridly integrated, or external modulator capable of operating at data rates > 10 Gb/s digital and up to 20 GHz analog over a temperature range of –40 to +85 °C. The package height must be < 0.140”. Required Phase II deliverables will include the following: 1) prototype digital tunable and fixed wavelength laser transmitters terminated with single-mode fiber including evaluation board; 2) prototype digital tunable and fixed wavelength laser transmitters terminated with 50-micron core multimode fiber including evaluation board; and 3) prototype analog tunable and fixed wavelength laser transmitters with single-mode fiber including evaluation board. Prototypes must maintain wavelength, power, and waveform stability in wide temperature range avionic network environments. Validate operational performance across 32 wavelengths (digital or analog).

PHASE III: Work with the Government, standards organizations, and military/aerospace contractors to commercialize military qualified opto-electronic modules for avionic WDM network applications. Thermoelectric components will be incorporated in opto-electronic components such as fixed wavelength laser diode sources and tunable laser diode sources used in avionics local area networks based on WDM technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private sector applications include metropolitan and local area networks for voice, video, and data communication. The primary beneficiary of this technology development will be the opto-electronics industry. The secondary beneficiary of this technology will be the fiber-optic network industry.

REFERENCES:
1. "Application of Thermoelectric Coolers in Laser Diode Packages,” Marlow Industries, Inc., Dallas, TX.
2. Venkatasubramanian, R., Colpitts, T., and O’ Quinn, B. “Thin Film Thermoelectric Devices with High Room-Temperature Figure of Merit.” Nature, Vol. 413, October 2001.
3. Gota, A., et al. “Hybrid WDM Transmitter/Receiver Module Using Alignment Free Assembly Techniques.” IEEE Trans. On Components, Packaging and Manufacturing Tech. – Part B, Vol. 21, No. 2, May 1998.
4. Coldren, L.A. “Monolithic Tunable Diode Lasers.” IEEE J. Quantum Electronics, Vol. 6, Issue 6, Nov/Dec 2000.
5. MIL-STD 810F, Environmental Engineering Considerations and Laboratory Tests.

KEYWORDS: Wavelength Selected Laser Diode; Tunable Laser Diode; Fiber-Optics; Transmitter; Thermoelectric Cooler; Electro-Optics

N04-004 TITLE: Advanced Radiating Apertures for Reduced Signature Platforms

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Design and analyze multi-band or wideband radiating apertures and arrays that enable multi-mission high-power electronic attack and sensing for reduced signature platforms.

DESCRIPTION: Current and past electronic attack techniques have typically been pre-emptive or reactive in nature. Future techniques must be responsive and provide real-time capability from the strike package or strike platform. In order to ensure deep penetration by the strike package, an electronic attack system integrated with the advanced airborne platforms is required. Reduced signature airborne platforms are constrained in their ability to install additional capabilities by the available airframe real estate and signature requirements. The addition of high-power radiating apertures for electronic attack utilizing existing aperture technology significantly increases the signature of the platform thereby decreasing the ability of those platforms to perform deep penetration. This can limit the number of weapons carried by the strike platform and consequently limit the strike package in its ability to provide self- and strike-package protection from various threat systems. There is a pressing need to increase the capability of new antenna apertures and arrays to support electronic attack. New aperture technology must have the following characteristics: scalable with high-power compatibility; able to handle high power with low-observable integration (particularly at lower frequencies); be electronically steered; have an agile beam; and support bandwidth requirements.

PHASE I: Design and analyze multi-band or wideband radiating apertures and arrays that enable multi-mission high-power electronic attack and sensing for reduced signature platforms. Indicate theoretical gain and frequency performance. Integrate the element model within a finite array lattice and predict antenna beam formation as a function of the scan angle and frequency. Polarization performance with scan angle should be characterized. Consider antenna performance in an environment that is compatible with reduced radar cross-section platforms.

PHASE II: Design, prototype, and test an integrated multi-band antenna array compatible with stated electronic attack requirements. Design and analyze a notional integrated electronic attack system and measure reduced scale installed system performance. Evaluate performance against predictions. Document the gain and polarization as a function of elevation angle. Tuning of the elements to optimize the performance over the frequency of interest is desired.

PHASE III: Complete antenna aperture and array design and transition technology to the Fleet.

PRIVATE SECTOR COMMERCIALIZATION POTENTIAL: Broadband conformal arrays have broad commercial potential for future transportation markets including commercial aircraft and automobiles. Specifically, communication systems have ever increasing bandwidth requirements as well as platform integration concerns.

REFERENCES:
1. Johnson, Richard. Antenna Engineering Handbook, 3rd Edition. New York: McGraw-Hill, 1992.
2. Kraus, John D. Antennas. New York: McGraw-Hill, 1988.

KEYWORDS: Multi-Band; Antennas; Wideband Radiators; Interleaved Arrays; Broadband; Communications

N04-005 TITLE: Small Multi-Decade Communication Antenna

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop a miniaturized multi-decade bandwidth antenna for omnidirectional broadband communication and electronic countermeasures.

DESCRIPTION: Advanced reduced radar cross-section aircraft require smaller, wider bandwidth, and more capable antennas. The frequency range from 100 MHz to 20,000 MHz (200:1) is of particular interest because this bandwidth encompasses the most crowded range of the RF spectrum. It is shared for a wide range of applications for communications, sensors, and countermeasures for such systems. Typical applications are global positioning system (GPS), ultrahigh frequency (UHF) satellite and line-of-sight communication radios, and Link-16 (JTIDS). These systems require antennas that are not only individually cumbersome but suffer from system degradation due to interference and blockage from other antennas. The purpose of this effort is to develop an innovative concept for a small antenna with greater than 200:1 bandwidth that can be used in a wide range of applications.

The particular emphasis of this program is to develop antennas for advanced aircraft. It is critical that the solutions be small, lightweight, low-volume, visually concealed, and low radar cross section (RCS). Typical broadband antennas (spirals) are at least .32 wavelengths at the lowest frequency of operation. Smaller sizes can be attained by loading the cavity but at excessively higher weight and more loss due to the properties of typical dielectric materials. In addition loaded cavity antennas are typically expensive due to the cost of cavity material. The goal of this effort is to retain all performance characteristics of the antenna while reducing the diameter of the antenna by a factor of 1.5 while reducing the cavity depth by another factor of 2, therefore achieving a 300-percent reduction on the overall size of the antenna.

PHASE I: Develop a theoretical model of the antenna. Predict the performance of the antenna in both aircraft installations. Development and test of breadboard models of the antenna are encouraged but not necessary. Document the design and predicted performance.

PHASE II: Construct and deliver a prototype of an antenna based on the designs of the Phase I program. Tests should be done in an environment emulating the intended applications of the antenna. Generate a report showing the results and comparisons to the theoretical models and any deviations from the expectations.

PHASE III: Complete development of the miniaturized multi-decade bandwidth antenna and transition technology to the Fleet.

PRIVATE SECTOR COMMERCIALIZATION POTENTIAL: Many commercial systems have requirements for broadband small antennas. Perfect examples are the commercial and general aviation aircraft industry with numerous antenna systems that are being added to all aircraft for a variety of applications. Other good examples are vehicular and personal communication antennas for a wide range of communication and navigation applications. It is expected that successful results of this effort will easily find applications to a wide range of commercial systems.

REFERENCES:
1. Johnson, Richard. "Frequent Independent Antennas." Antenna Engineering Handbook, 3rd Edition. New York: Mc-Graw Hill, 1992.
2. Kraus, John D. Antennas. New York: Mc-Graw Hill, 1988.

KEYWORDS: Antennas; Broadband; Communications; Electronic Warfare; Global Positioning System; Joint Tactical Radio System

N04-006 TITLE: Noncooperative Tracking of Underwater Vehicle

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Air ASW Systems, Maritime Surveillance Aircraft

OBJECTIVE: Develop innovative devices that would detect and track underwater vehicles and reduce the adversary’s ability to hide, take evasive maneuvers, or conduct tactical operations.

DESCRIPTION: Air antisubmarine warfare (ASW) missions operating in shallow water make it extremely difficult to track and locate underwater vehicles. Exploiting recent advances in both acoustic and nonacoustic sensor technology may provide an opportunity for new tagging, marking, and detection capabilities. The challenge will likely be to extend any concepts that are currently feasible in laboratory environments to practical field applicability.

Technical approaches may include the use of mammals, microscopic structures, or devices that adhere to a marked entity and that either passively or actively contrast it from unmarked entities. Mandatory attributes include real-time detection of markers and the use of coding to correlate markers to specific operations, locations or dates. Operational simplicity, robustness, and low cost are also desirable.

PHASE I: Develop and refine the proposed concept to the point where system performance capabilities and limitations could be reasonably predicted and system design tradeoffs could be quantified.

PHASE II: Develop and fabricate laboratory breadboard experimental prototypes of both markers and appropriate detection equipment, and demonstrate them in a laboratory setting, which simulates the anticipated key issues associated with field use.

PHASE III: Perform simulated operational demonstration as part of an air ASW tagging field exercise.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Potential applications include law enforcement, wildlife tagging, and monitoring.

KEYWORDS: Tagging; Marking; Tracking; Detection; Sensors; Antisubmarine Warfare

N04-007 TITLE: Continuous Active Sonar (CAS)

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Air ASW Systems

OBJECTIVE: Develop low-power CAS technology to solve the localization to attack problem for airborne antisubmarine warfare (ASW).

DESCRIPTION: The Navy has a requirement for an improved localization capability for the airborne ASW mission. Current acoustic localization systems utilize a traditional pulse type sonar approach. The requirement for increased performance has resulted in an emphasis of higher power systems that require extensive marine mammal mitigation procedures for test and employment. A low power alternative, which would be more environmentally friendly toward marine mammals while maintaining required performance, is desired. Continuous wave systems that operate at lower average power could provide a solution to these requirements. Although continuous wave systems have been used for radar applications, their possible applicability to acoustic localization systems has never been determined. The purpose of this program is determine if a CAS system employing sonobuoys can be effective in performing the airborne localization mission and to define the critical system parameters for such a system. The critical CAS system parameters will include the “optimum” tactical operating frequency, time of operation (life) requirements, power requirements, recommended waveforms, processing techniques and processing gain achievable, and tactics. Both deep and shallow environments should be considered. Sonobuoy size is restricted to A size (36 inches long, 4 7/8 inches diameter, and 39 lbs).

PHASE I: Develop and demonstrate preliminary design for a CAS localization-to-attack sonobuoy system.

PHASE II: Complete detailed system design. Develop and demonstrate a prototype by field-testing critical design parameters.

PHASE III: Perform over-the-side testing (OTS) testing of the prototype.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology applies to submerged object detectors for salvage, harbor defense system.

REFERENCES:
1. “Sonobuoys”. FAS Military Analysis Network. http://www.fas.org/man/dod-101/sys/ship/weaps/sonobuoys.htm
2. “Approved Navy Training System Plan for the Navy Consolidated Sonobuoys. N88-NTSP-A-50-8910B/A, dated September 1998. http://www.stl.nps.navy.mil/~brutzman/Savage/CommunicationsAndSensors/Sonobuoys/ntsp-Sonobuoy.pdf

KEYWORDS: Continuous Active Sonar; Sonobuoy; Localization; Attack; Anti-Submarine Warfare; Acoustic

N04-008 TITLE: Improved Crashworthy Seating for Naval Helicopters

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Aircrew Systems, H-60 Multi-Mission Helicopters

OBJECTIVE: Develop a lightweight crashworthy seating system capable of mitigating the high levels of inertial forces that would otherwise be imparted to an occupant during a crash impact.

DESCRIPTION: During a helicopter crash impact, a combination of high velocity and short stopping distance can produce peak decelerations in excess of 50 g. This type of rapid deceleration results in the imposition of very high inertial loads on the aircraft and its occupants. The forces are so great that they have a high potential for inflicting serious spinal injury on occupants not protected by energy attenuating seating systems. Before the integration of such systems into naval helicopters, the number one cause of fatalities and injuries in survivable helicopter accidents was the failure of seats to retain the occupants and limit the vertical forces. For this reason, many naval helicopter platforms have incorporated seating systems designed to reduce an occupant’s exposure to the rapid deceleration profiles associated with crash impacts. Incorporation of these seating systems has reduced the number of injuries, the number of fatalities, and the costs associated with a naval rotorcraft mishap.

However, there are platforms that have not installed these types of systems because the weight penalty associated with the installation of these seating systems would adversely affect the operational performance of the aircraft. In other cases, the physical dimensions of the cockpit and cabin will not allow for implementation of these types of seating systems. Therefore, there is a high level of interest in developing crashworthy seating and other energy attenuating systems capable of maintaining current levels of occupant crash protection at weights that are well below those of the conventional solutions. Of particular interest are concepts that take advantage of lightweight materials to provide an increase in structural efficiency over current designs whose main load-bearing members are comprised of conventional metals.

The candidate crashworthy or energy management technologies also needs to have a goal system weight of 10 pounds and be amenable to integration into existing and future naval and joint Service rotorcraft. The candidate system must be capable of meeting naval injury tolerance standards for body regions such as the head, neck, chest, pelvis, and lumbar spine. Additionally, improved provisions for seat stowage, and accommodation of body-borne combat equipment is a highly desirable outcome of this program. Of particular concern are the following aspects of stowage:

· Volume of stowed seat –concepts to minimize the stowed volume of the seating system are desired.
· Seating system’s susceptibility to damage while being removed from an aircraft and/or while being stowed.
· Seat compatibility with body-borne equipment such as ALICE/MOLLY packs.

Seat system service life should also be addressed; the Navy is interested in a minimum service life of 10 years. The seating system should, at a minimum, provide crash protection to occupants weighing 140 – 240 pounds.

PHASE I: Determine the feasibility of incorporating lightweight materials with dynamic performance characteristics into crashworthy seating designs.

PHASE II: Prototype the design approaches that are most consistent with the goal of reducing the seating system weight to 10 pounds or less. Subject the prototype to crash impact loads. The design will be iteratively refined during this phase of development.

PHASE III: Demonstrate the mature design solutions.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is a need for improvement (and in some cases implementation) of crashworthy seating systems for civil rotorcraft. Development of seating systems that significantly reduce the weight of conventional designs will most likely result in an acceleration of implementation of these systems into civil rotorcraft.

REFERENCES:

1. Aircraft Crash Survival Design Guide, Volume II - Aircraft Design Crash Impact Conditions and Human Tolerance, December 1989.
2. Aircraft Crash Survival Design Guide, Volume IV – Aircraft Seats, Restraints, Litters, and Cockpit Delethalization.
3. Jackson, Karen E., Fasanella, Edwin L., and Boitnott, Richard. "Occupant Responses in a Full-Scale Crash Test of the Sikorsky ACAP Helicopter, U.S. Army Research Laboratory." Vehicle Technology Directorate, Hampton, Virginia. Also McEntire, Joseph, and Lewis, Alan. U.S Army Aeromedical Research Laboratory, Fort Rucker, Alabama.
4. Virtual Naval Hospital United States Naval Flight Surgeon's Manual; Third Edition, 1991, Chapter 22, Emergency Escape From Aircraft. http://www.vnh.org/FSManual/22/10Crashworthiness.html

KEYWORDS: Crashworthy; Energy-Attenuating; Cost-Effective; Lightweight; Developmental Seating; Spinal, Head and Neck Injury Reductions

N04-009 TITLE: Military Gas Turbine Engine High-Cycle Fatigue (HCF) Mitigation

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: T45TS Naval Undergraduate Flight Training Systems, V-22

OBJECTIVE: Develop modeling, design, and test tools that can be used to reduce aircraft gas turbine engine failure due to HCF.

DESCRIPTION: HCF results from vibratory stress cycles induced from various aeromechanical sources on military gas turbine engines. HCF is a widespread phenomenon in military gas turbine engines, which leads to premature failure of major engine components (fans, compressors and turbines) and has resulted in in-flight shutdowns, increased maintenance costs, decreased readiness, and, in some cases, the loss of aircraft. Between 1982 and 1996, HCF accounted for 56 percent of Class-A engine-related failures. HCF is a major factor that negatively impacts safety, operability, and readiness, while at the same time substantially increasing maintenance costs. For example, in fiscal year 1994 HCF required an expenditure of 850,000 maintenance man-hours for risk management inspections. Estimates today put the cost resulting from HCF at over $400 million per year.

New high-performance turbofan and turboshaft engines (F405, T406, F414, and F119) in development and their derivatives have a large affinity for new HCF problems never encountered previously. To date, there is an immature level of HCF design systems and deficiencies capable of predicting forced response characterization and assessing the material response (HCF/low-cycle fatigue, fretting, etc.) and damping characterization. Increasing the understanding will help in the design, development, and demonstration of HCF mitigation technologies. Areas of interest to be addressed could include one or more of the following:

- Methods for aeromechanics characterization in inducing HCF
- Forced response prediction
- Innovative nonintrusive measurement sensors and instrumentation used to measure HCF critical parameters
- Component analysis techniques used for design and analysis
- Material damage tolerance resistance research
- Passive damping processes

PHASE I: Assess the applicability, feasibility, and practicality of predicting and characterizing HCF mechanisms and developing design tools and innovative HCF mitigation technologies required to reduce HCF in advanced and current high performance gas turbine engines.

PHASE II: Perform one or more of the following: develop damping characterization and design methodologies and tools used for modeling and analyzing HCF; develop damage tolerance characterization methodologies and techniques used to increase the damage tolerance to foreign object debris; develop the HCF methodology and measurement techniques used for HCF validation testing and material characterization; perform subscale development of the manufacturing/deposition process/surface treatments used for mitigating HCF.

PHASE III: Conduct subscale demonstration of the HCF materials/processes/surface treatments used to verify their potential for mitigating HCF issues for use in aircraft gas turbine engines.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology is pervasive across all aircraft gas turbine engines and has direct applicability to the civilian aviation market engine manufacturers. Use of this capability will contribute to significant savings in maintenance, reduce O&S costs, increase on-wing engine time by allowing for solutions early in the design process of new gas turbine engines or solving HCF problems on fielded engines for commercial airline, regional jet and business jet applications.

REFERENCES:
1. HCF Science & Technology Program FY 2001 Annual Report AFRL-PR-WR-TM-2001-2148.
2. High-cycle fatigue: www.hcf.utcdayton.com

KEYWORDS: High-Cycle Fatigue; Turbine Engines; Modeling; Gas Turbine Engine Damage Tolerance; Damping; Surface Treatments

N04-010 TITLE: Self-Evolving Maintenance Knowledge Bases

TECHNOLOGY AREAS: Air Platform, Materials/Processes

OBJECTIVE: Develop advanced technology to integrate prognostic and health maintenance information from a variety of different sources into a dynamically evolving knowledge base.

DESCRIPTION: The health of complex equipment is dependent on different factors including usage, routine maintenance, unscheduled maintenance, replacement part quality, etc. The result is a complex interaction of the different components that makes predicting the overall system health nontrivial and often includes some uncertainty. An asset readiness management system must make operations and maintenance strategy decisions based on prognostic and health maintenance (PHM) assessments that contain some level of uncertainty and other information, such as logistics, maintenance schedules, and mean-time-to-repair data that also include variation. Since optimal decision-making depends on reliable information to correctly predict operations and maintenance strategies, it is critical to continually evolve the knowledge base (whether it be the PHM system rules, mean-time-to-repair data, or uncertainty in the supply chain) using feedback from actual work performed to improve future decision-making capability.

PHASE I: Define the techniques and processes needed to track maintenance actions including parts used, procedures undertaken, test results, damage found, etc. Design a strategy to develop the advanced techniques for feedback of maintenance actions and integration needs with other systems. Develop and demonstrate a prototype methodology for updating the knowledge base for a subset of maintenance actions associated with and aircraft asset readiness system.

PHASE II: Develop and demonstrate a prototype for these advanced tracking programs for several maintenance actions. Assess the application boundaries, accuracy, and limitations for the proposed methodology. Develop, validate, and deliver a complete set of application programs and techniques for self-evolving knowledge bases using completed maintenance action items as input for the update.

PHASE III: Work with an engine prime contractor to finalize the design and integrate it into a comprehensive asset readiness management system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The self-evolving knowledge base technology would be applicable to any system that utilizes a core knowledge database as a repository of information critical for automated decision-making. More specifically, a knowledge database whose information content can be adapted based on feedback from actual actions could leverage the developed technology. Any results (understanding) gained from the development of a self-evolving knowledge base would provide significant crossover benefit to other applications, commercial or military, where data adaptation based on feedback is required for improving future automated decision-making capability.

REFERENCES:

1. Open Standards for Operations and Maintenance, http://www.mimosa.org
2. Henley, Simon, Currer, Ross, Sheuren, Bill, Hess, Andy, and Goodman, Geoffrey. "Autonomic Logistics-The Support Concept for the 21st Century," IEEE Proceedings, Track 11, paper zf11_0701.
3. Byer, Bob, Hess, Andy, and Fila, Leo. "Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics," Aerospace Conference 2001, IEEE Proceedings, vol. 6, pp. 3095, 3103.
4. Joint Strike Fighter, http://www.jsf.mil

KEYWORDS: Diagnostics; Prognostics; Modeling; Tracking; Condition Maintenance; Knowledge Base

N04-011 TITLE: Next Generation Data Fusion Architecture

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: E-2/ATDS, F/A-18

OBJECTIVE: Develop and demonstrate the "ideal" or next generation data fusion architecture as applicable to an airborne command and control platform with multiple sensors and sources (platforms).

DESCRIPTION: Combining data from multiple sources into a single coherent "picture" is a fundamental challenge to battlespace management. Today's combat systems are a result of the Department of Defense's historical federated acquisition process. These individual development programs produced individual stovepiped systems, now part of the legacy baseline. Comprising various interfaces, information structure, and data elements, these incompatible systems are difficult to integrate within a Service, and nearly impossible to integrate across Services. This has hindered interoperability within battlespace operations because of the inability to take advantage of intelligence and open sources of information. Next generation architecture should provide real-time fusion performance monitoring capability and algorithm assessment that permits development of an exploration platform to capture algorithm performance information and development of an optimal solution based on actual performance with the system's data.

The overall goal of this effort is to produce an efficient and portable data fusion solution for the E-2C. This solution will break down the technical barriers associated with interoperability and will allow legacy and new systems to seamlessly interoperate, while minimizing processing and bandwidth resources to fit within existing system capabilities. The proposed solution should be an open architecture and be able to handle input data from local sensors, data links and satellite communications (SATCOM) as well as electronic intelligence (ELINT), imagery intelligence (IMINT) and signal intelligence (SIGINT) data.

PHASE I: Demonstrate the feasibility of the proposed open system architecture to support the single display information flow concept. In this context, an "open system" is one that invokes sufficient open specifications for interfaces, services, and supporting formats to enable properly engineered components to be used across a wide range of systems with minimal changes and to interoperate with other components on local and remote systems. Evaluate the effectiveness of the user interface for fusion control and the effectiveness/efficiency of the infrastructure support functions.

PHASE II: Develop, build, and demonstrate flexible and portable execution architecture. This architecture should allow new fusion algorithms to be included and assessed in the future, and should provide a landing pad for the migration to newer technologies as the technology is refreshed.

PHASE III: Transition the advanced architecture into the E-2C, the Navy airborne command and control platform, as well as other platforms that perform data fusion within and outside the Navy. A successful transition will involve coordination with Naval Air Systems Command, Northrop Grumman, and possibly several subcontractors that have developed or are developing fusion software on their own.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Military application of this technology is the exchange and management of track information among networked military command and control systems. The technology developed under this program will have application to any commercial activity that shares data generated from multiple sources over a distributed environment. The algorithms that are developed will have application to the commercial shipping industry, financial industry, environmental sensing, commercial aviation, and intelligent vehicle highway systems (IVHS). Currently, the Internet has connected the traffic flow monitoring of major highways in most cities. Smart sensor web activities have both military and commercial applications to the detection, identification, and management of moving ground vehicles.

REFERENCES:

1. Waltz, E. and J. Llinas. Multi Sensor Data Fusion. Boston: Artech House, 1990.
2. Pawlowski A., and P. Gerken. "Simulator, Workstation, and Data Fusion Components for Onboard/Offboard Multi-Target Multi-Sensor Fusion". Presented at 17th IEEE/AIAA Digital Avionics Systems Conference, Seattle, Washington, November 1998.
3. Malkoff, D., and A. Pawlowski. "RPA Data Fusion". Presented at National Symposium on Data Fusion, Monterey, California, March 1996.

KEYWORDS: Track; Radar; Database Management; Distributed Collaborative Environment; Data Fusion; Battlespace Management

N04-012 TITLE: Ceramic Hybrid Bearing Fault Detection

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop capabilities to detect failures of ceramic rolling elements in hybrid bearings.

DESCRIPTION: Rotorcraft drive systems use numerous bearing designs with steel rolling elements and steel inner and outer races. The steel rolling elements could be replaced with ceramic elements, creating a ceramic hybrid bearing. This can yield significant weight savings and increased loss-of-lubrication performance for the drive system. Besides providing a significant weight reduction, ceramic hybrid bearings provide other advantages over steel element bearings. Ceramic elements have stable mechanical properties at temperature in excess of 2,000ºF whereas the useful temperature for a typical high hot hardness bearing steel like M50 is only 600ºF. This makes a ceramic element bearing an excellent candidate for improved loss-of-lubrication performance, especially in the high sliding and high heat generating spherical roller bearing application for planet bearings. Another advantage due to the reduced weight of the elements is a significant reduction in the centrifugal load of the elements on the outer race. This can reduce loading, stresses, and heat generation on high-speed and/or large-diameter bearings. A final advantage of ceramic elements is that they are corrosion proof. Corrosion in steel bearings is a major cause for replacement at overhaul and plays a significant role in the initiation of pitting failures.

One of the disadvantages is the inability to detect a pitting or spalling failure of the ceramic element with the common rotorcraft chip detection system since the ceramic material is nonmagnetic. Recent advances in bearing vibration diagnostics allow failure detection of rolling elements in stationary bearings supporting a rotating shaft, but are limited in their ability to detect a bearing failure of a rotating planet bearing. However, tests conducted by a major helicopter manufacturer under the advanced rotorcraft transmission (ART) Phase I program showed the failure mode of a spalled ceramic element to be very similar to that of a steel element and not catastrophic. Furthermore, the pitted or spalled element quickly transferred damage to the inner race of the bearing, which also spalled, generating metallic debris picked up by the chip detection system.

PHASE I: Identify and define a ceramic hybrid bearing fault detection technology. The concept should have the ability to detect pitting or spalling failures of ceramic rolling elements. Characterize the concept and determine its potential effectiveness based upon available data.

PHASE II: Develop and refine this design to include possible materials and manufacturing methods needed to produce any components critical to this concept. Document the analytical tools and methodology required in the design/manufacture of a prototype fault detection system. Develop a test plan for bench testing of the design concept.

PHASE III: Team with a helicopter prime manufacturer or a major DoD transmission supplier to manufacture and test a gearbox to validate the ceramic hybrid bearing fault detection system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The same fault detection system would be applicable to all aircraft gearboxes.

REFERENCES:
1. AS3694A, Transmission Systems, VTOL/STOL, General Requirements for.
2. MIL-D-23222 Military Specification, Demonstration Requirements for Helicopters.

KEYWORDS: Ceramic Bearings; Chip Detector; Fault Detection; Hybrid Bearing; Debris; Sensor

N04-013 TITLE: High-Speed Machining of Thin-Web, Large-Pocket Ti-6Al-4V Firewalls/Bulkheads

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: V-22

OBJECTIVE: Demonstrate a high-speed machining process for thin-web, large-pocket Ti-6Al-4V firewalls and bulkheads, and determine the material properties resulting from the combined processes (such as high-speed machining, chemical milling, and ion vapor deposition).

DESCRIPTION: Aircraft structures require highly efficient designs to minimize weight. Titanium firewalls are not generally considered part of the primary structure. They can therefore be designed for minimum thickness to minimize weight. Current titanium firewall designs utilize titanium sheet construction to accomplish this purpose, but at a sacrifice of assembly time and cost (both recurring and nonrecurring). The high-speed machining of titanium can eliminate the assembly time but may not yield thicknesses of 0.032" (or less) in large web areas that the current sheet metal approach achieves.

The U.S. Navy is seeking innovative and scalable high-speed machining process(es) for fabricating Ti-6Al-4V firewalls/bulkheads for aircraft applications. In particular, the impact of material properties (strength and fatigue) from a combined process (such as high-speed machining, chemical milling, and ion vapor deposition) should be assessed. It is anticipated that the results of this work will lead to process and design guidelines to allow a minimum gauge machined firewall/bulkhead that has the lowest weight and cost and maintains its functionality.

PHASE I: Demonstrate the scientific merit and feasibility of the proposed high-speed machining process for making thin-web, large-pocket Ti-6Al-4V firewalls/bulkheads with electrical ground paths. A design of experiment (DOE) approach is encouraged to establish the objective/threshold of the process variables including pocket web thicknesses, areas, and stiffener heights for the combined processes. Prototype samples should be characterized microstructurally, and mechanically tested per AMS 4985 for strength and fatigue durability.

PHASE II: Fabricate and characterize the full-scale prototype component based on the Phase I effort. In this phase, the contractor is expected to work with the aircraft manufacturer(s) to select the candidate components for testing. It is anticipated that full-scale testing for assessing material strength and fatigue properties will be performed in this phase.

PHASE III: Generate guidelines and material property allowables for use in design and validation of structural components. Produce and qualify components using the high-speed machining process and transition to the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: More widespread usage of titanium components using high-speed machining process is expected for the aerospace industry.

REFERENCES:

1. AMS 4985: (R) Titanium Alloy, Investment Castings, 6Al-4V 130 UTS, 120 YS, 6% EL Hot Isostatically Pressed Anneal Optional or When Specified, January 1997, Society of Automotive Engineers Aerospace Materials Specification.

KEYWORDS: Ti-6Al-4V; High-Speed Machining; Chemical Milling; Firewalls; Bulkheads; Structure

N04-014 TITLE: Low-Observable Remote Sensor Deployment

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace, Weapons

ACQUISITION PROGRAM: Air ASW Systems

OBJECTIVE: Develop an air deployment concept for expendable sensors that features stand-off launch, low observability, and accurate placement.

DESCRIPTION: There are a number of military applications that require the deployment of unattended sensors into locations that are, for a variety of reasons, inaccessible or where it is undesirable or dangerous to be observed. These include antisubmarine warfare (ASW), drug interdiction, homeland defense, and anti-terrorist missions.

This effort will be directed towards developing an integrated sensor/remote deployment concept. The device must be inexpensive enough to be considered expendable. It must have the capability of being launched from military aircraft/unmanned air vehicles (UAVs) and then flying to a pre-set location up to 50 miles away. It must not require any in-flight course correction by an operator. It must be adaptable to a number of environments, including ocean, forest/jungle, and open terrain. It must reliably deploy the appropriate sensor and communications link. Once in place, the sensor package must blend in with the environment so as to be difficult to detect visually.

Currently fielded sensor and deployment systems do not provide all of this capability. This effort will extend current state-of-the-art with the development of a novel integrated covert sensor and remote standoff deployment package.

PHASE I: Demonstrate the feasibility of a sensor/deployment concept that will address the technical challenges of the flight characteristics, sensor/link deployment, and low observability.

PHASE II: Develop the recommended technology(s) and hardware design. Assemble a prototype and conduct a demonstration of the capability. Finalize the concept design and make recommendations for Phase III production-oriented designs.

PHASE III: Develop production design and conduct integrated testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This concept would have multiple applications for law enforcement agencies concerned with homeland defense and anti-drug operations along U.S. borders, as well as traditional military force projection.

REFERENCES:

1. Sonobuoy Technical Reference Manual, NAVAIR 28-SSQ-500-1.
2. Srour, Nino. "Unattended Ground Sensors A Prospective for Operational Needs and Requirements – Prepared for NATO Land Group 6 on Battlefield Surveillance, Target Acquisition, Night Observation, Countersurveillance and Electronic Warfare." U.S. Army Research Laboratory, October 1999.
3. DARPA Information Exploitation Office – Programs at a Glance, http://dtsn.darpa.mil/ixo/programs.asp.
4. Lang, Stephen. "Military Applications and Requirements for Air-Acoustics," http://www.darpa.mil/MTO/sono/ presentations/Sanders.pdf.
5. P-3 Tactical Manual, NTTP 3-22.5 P-3 TACMAN.
6. RQ-1 Medium Altitude Endurance (MAE) UAV, http://www.globalsecurity.org/intell/systems/predator.htm.

KEYWORDS: Sensors; Air Deployment; Low Observability; Remote Sensors; Unattended Sensors; Expendable

N04-015 TITLE: Multi-Source Vertical Obstruction Generation

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Cruise Missile Command and Control Systems

OBJECTIVE: Develop a tool (or tools) to automatically detect, geo-locate, and determine the height above ground of vertical obstructions over an operational area. The tool must also assess the accuracy, both horizontal and vertical, of any detected vertical obstructions. It must also only detect obstructions above a certain height.

DESCRIPTION: Vertical obstruction data, consisting of tall man-made objects such as buildings, towers, power lines, etc., have been an essential part of route planning of low-flying air vehicles. These objects provide piloted aircraft with a means of situational awareness of potential flight hazards. Unmanned vehicles, such as cruise missiles, have used vertical obstruction databases as a source to generate routes that avoid these structures. Existing databases are for only portions of the world and are dated.

For a specific high-priority mission, existing sources with existing methods can be used to generate vertical obstructions along a specific path. The National Imagery and Mapping Agency (NIMA) provides digital point positioning data bases (DPPDB), which provide broad area optical stereo imagery, and can be used to generate high-resolution digital elevation models (DEMs) that contain vertical obstructions. This is a time-consuming method. Also, DPPDB may not cover all areas of concern and may not reflect the current tactical picture.

Recent developments have provided the opportunity to receive higher resolution data that may also be useful for detecting and locating vertical obstructions. The space shuttle conducted the "Shuttle Radar Topography Mission" (SRTM), which collected digital terrain elevation data (DTED) level II (30-meter post spacing) over 80-percent of the Earth's land mass. In addition, even higher resolution DEMs are being generated from various sources in support of applications requiring high precision such as battle space visualization, perspective scene generation, and precision terrain aided navigation (PTAN).

Vertical obstruction data can be derived from multiple sources. A variety of databases exist that contain power lines, oil rigs and platforms, radio towers, buildings, industrial plants, etc. The completeness, age, and accuracy of these databases need to be accounted for when incorporating their information. Multi-spectral imagery is also available from a variety of open, tactical, and national sources. These sources can provide overlapping areas of coverage. All these can be used to automatically generate a vertical obstruction database for an operational area.

PHASE I: Research and develop mathematical techniques for detecting man-made objects above a given height threshold from the surrounding terrain and natural features, from a variety of source material to include tactical, national, and open sources. Objects to be detected include buildings, towers, power lines, bridges, etc. Assess the feasibility of employing these techniques to automatically detect, geolocate, and determine height from each of the data sources separately and together in a multi-source fusion process. Validate the vertical obstruction database with ground truth to characterize the accuracy of each data source and provide an estimate of the accuracy, horizontal and vertical, for each obstruction. The mathematical techniques should be based upon an understanding of rigorous sensor models and basic sensor parameters that affect DEM accuracy and precision.

PHASE II: Develop a prototype tactical vertical obstruction base capability, which employs the fusion techniques developed in Phase 1 and demonstrate its utility. Integration with Government or commercial software packages and databases is highly recommended to show feasibility and demonstrate and validate the performance of fusion techniques with commonly used systems and data. Assess system throughput and estimate the ability of the prototype to be effective with high-volume data environments. Conduct an assessment of source material quality and optimize/tune algorithms for better performance. Embed quality metrics within the vertical obstruction database as part of the automated process to allow users to assess the confidence level of each element identification, location, and height.

PHASE III: Full-scale development of the tactical vertical obstruction database and integration into the Tomahawk command and control system (TC2S).

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability can be applied to the commercial market sector in a wide range of applications that includes agriculture, visibility, traffic, and hydrographic analyses; imagery ortho-rectification, map production, and imagery visualization.

KEYWORDS: Vertical Obstructions; DEM; Multi-Source Data Fusion, Change Detection; DTED; Situational Awareness

N04-016 TITLE: Intelligent Aircraft/Ship Data Analysis Options

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop and demonstrate intelligent aircraft/ship data analysis tools to support current and future aircraft/ship testing and related analytical work.

DESCRIPTION: The Navy employs aircraft ranging from unmanned aerial vehicle (UAV) to rotorcraft, vertical take-off and landing (VTOL), and fixed-wing configurations, and these aircraft may operate aboard ships ranging from surface combatants to nuclear powered carriers. Testing is required to determine the operational limits of each type aircraft operating aboard specified classes of ships. This large combination of aircraft types and ship classes results in a large test matrix. The test aircraft may have on-board data acquisition systems or the testing may be done with a non-instrumented fleet aircraft. The ship-based test team may have data systems that measure ship motion, ship speed and direction, and wind over the deck speed and direction, plus record video and still photos, audio, and ship airwake.

The current Navy rotorcraft dynamic interface database contains limited information on over 200 at-sea tests in a DBASE III format that is difficult to use. The Navy fixed-wing community does not have an aircraft/ship flight test database. Flight test data are required to validate ongoing aircraft/ship modeling that may be used to help support and reduce the cost associated with conventional testing. Ongoing aircraft/ship analytic work involves aircraft models and computational fluid dynamics (CFD) and wind tunnel ship airwake models. The model airwake data generated in a single CFD ship airwake/motion run or a few seconds of wind tunnel particle interference velocimity (PIV) airwake data can easily exceed 100 GB of storage. Intelligent aircraft/ship data analysis tools are required to better support current and future aircraft/ship testing and related analytical work.

PHASE I: Develop an initial design concept showing how intelligent analytic tools can be used to help enhance each phase of the aircraft/ship test and analytic work. Provide an initial demonstration that shows the potential to support a specified aircraft/ship test planning exercise with interface to available aircraft/ship databases. Provide an initial demonstration showing how the intelligent software could be used to support an aircraft/ship analytic test program.

PHASE II: Develop the intelligent software programs to support aircraft/ship testing and related analytic work. Develop prototype software and demonstrate usefulness in supporting test planning, data acquisition, storage, analysis, envelope plotting, and report generation for specified VTOL/fixed wing and rotorcraft/UAV aircraft shipboard testing. Demonstrate the ability of the intelligent software to optimize the large aircraft/ship analytic database and support an analytic aircraft/ship test program. Develop validation options for the intelligent software program applications to support aircraft/ship flight-testing and for related analytic work.

PHASE III: Apply the intelligent aircraft/ship data analysis options to support an Army aircraft/ship test program. Also apply the intelligent aircraft/ship data analysis options to all planned aircraft operations and associated modeling required for future ships like the LHA(R).

PRIVATE SECTOR COMMERCIAL POTENTIAL: The enhanced ability to work with large aircraft/ship flight test and analytic databases could also be demonstrated to the Coast Guard and to industry. The results of this topic could also be applied to commercial shipping activities and to the FAA.

REFERENCES:
1. Carico, Dean. "Toward Automating the Helicopter/Ship Dynamic Interface Database." International Test and Evaluation Association (ITEA) Workshop on Automation Initiatives in Test and Evaluation, Patuxent River, Maryland, September 1987.

KEYWORDS: Artificial Intelligence; Test Planning; Dynamic Interface; Aircraft; Ship; Data Acquisition

N04-017 TITLE: Low Coefficient of Friction Gear Coating

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop an innovative gear wear coating that has the capability to continue performing for a specified period of time, even if there is no gear lubricant present.

DESCRIPTION: Rotary platforms have a run dry requirement that requires the transmission system to survive 30 minutes without lubrication. Black oxide coated helical gears on current rotary platform drive trains barely meet the loss-of-lubricant survivability requirement and require an expensive auxiliary lubrication system. The extra system also adds weight to the airframe. A gear coating is desired that substantially outperforms black oxide in this application. Desirable properties for the coating include non-line-of-sight deposition, excellent adhesion as coated and under stress (resistance to spalling), low coefficient of friction, low life-cycle cost, low environmental impact, and ability to be used on a variety of substrates. A viable candidate could allow for the elimination of the backup lubrication system and extend the run dry performance of the transmission, increasing safety of flight. Typical gear operating parameters include gear pitchline velocity, which is commonly 300 ft/sec to 550 ft/sec, and tooth contact stress of 250 ksi.

PHASE I: Develop an innovative method for producing a gear coating that has the potential for meeting the Navy's loss-of-lubricant requirement. Establish the feasibility of the proposed process by performing screening tests. With input from the U.S. Navy, determine the applicability of the new gear coating process for specific naval aircraft applications.

PHASE II: Continue optimization of the gear coating process. Characterize and validate coating composition, uniformity, and microstructure and physical characteristics like wear, hardness, adhesion, fluid resistance, corrosion resistance, thermal stability, and fatigue effects on substrate. Specific aircraft parts will be selected to apply the gear coating. These parts will be chosen to optimize the benefit of the loss-of-lubricant requirement. After selected parts are coated, they should be tested for the following properties: gear surface fatigue pitting, gear surface scoring resistance; gear tooth bending fatigue; and loss-of-lubricant performance. If necessary, scale-up of the gear coating process will be performed during this phase.

PHASE III: Transition the gear coating replacement process to military and commercial aircraft, as well as numerous other commercial gear applications that may benefit from this coating.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial potential of this gear coating is substantial. The ability of a gear coating to work properly without the benefit of lubrication has many applications in the defense and commercial sector where gears are utilized.

REFERENCES:

1. AMS2485J, "Coating, Black Oxide." Society of Automotive Engineers Aerospace Materials Specification, October 2002.

KEYWORDS: Wear; Low Coefficient of Friction; Adhesion; Coating; Gears; Loss of Lubricant

N04-018 TITLE: <u>Design and Life Prediction Methodologies for Weight Efficient Ceramic Matrix Composite (CMC) Propulsion Components</u>

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop methodologies for design and life prediction of weight efficient CMC propulsion system components. The methodologies should support application of the CMCs in turbine and exhaust system components on the JSF propulsion systems.

DESCRIPTION: The Navy has an immediate need to reduce the weight of the JSF propulsion system. Many of the components comprising the system are metallic and weight inefficient. CMCs offer the potential for weight reduction; however, design and life prediction methodologies are unproven and immature. The propulsion system currently under development for the JSF includes the F135 and F136 engines. These engines are being designed to be interchangeable on the aircraft and will have a common exhaust nozzle assembly. It is, therefore, logical to consider this nozzle system as the starting point for CMC application. Critical to the design of these components is the ability to model the CMC material accurately and predict their thermal-mechanical behavior under the environmental conditions to which they may be exposed. These conditions may include oxidation and hot corrosion arising from the salt and exhaust gas environment. Existing CMC design tools are not readily available and CMC design practices are not completely understood by the propulsion system designer. Life prediction methodologies have yet to be fully developed to enable assessment of CMC components subjected to the severe thermal conditions, let alone the environmental conditions, under which Navy aircraft operate. To fully utilize the potential of CMCs for weight reduction and enhanced durability of propulsion components, design methodologies and life prediction tools must be available and validated. The developed design and life prediction methodologies may rely on existing approaches and design practices; utilize innovative analytical modeling concepts; and/or consider knowledge-based criteria.

PHASE I: Develop new methodologies or utilize existing approaches to design and determine life expectancy of CMC propulsion system components. Demonstrate the feasibility of the approach by designing, fabricating, and testing prototype CMC subelements representative of the CMC component. Provide preliminary data, which show confidence of the design methodology and indicate the ability of the design to withstand the harsh environment. Analytically show that the proposed concept for the CMC component meets the design requirements of the existing configuration.

PHASE II: Package the design and life prediction methodologies defined under Phase I into a toolkit for use by the propulsion system designer. Utilize these analytical approaches to develop the detailed design of CMC propulsion system components, including attachment concepts and fabrication methods. Demonstrate produceability by fabricating full-scale components. Demonstrate the ability of the design to withstand the hot corrosive environment. Evaluate the performance of the component under realistic simulated flight conditions.

PHASE III: Utilize the methodologies developed and the design and fabrication method of the JSF propulsion component to transition the technology to other applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Advanced CMC propulsion components have the potential to transition to the commercial aircraft market for weight reduction and enhanced life expectancy. The resulting analytical approaches, material designs, and fabrication methods can transition to the energy and chemical industries for such applications as hot gas filters, radiant burners, corrosive handling equipment, waste incinerators, and power turbines.

KEYWORDS: Ceramic Matrix Composites; Propulsion; Flaps; Seals; Exhaust Nozzle; Life Prediction

N04-019 TITLE: Damping Coatings for Gas Turbine Compression System Airfoils

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop a thin, durable damping coating for titanium blades, vanes, and stators that provides a significant reduction in airfoil aeromechanical response without a negative impact on material fatigue capability.

DESCRIPTION: One-piece integrally bladed rotors (IBR's) are becoming increasingly popular in both military and commercial engine compression system components. In general, IBR's are lighter weight and offer performance benefits, through reduced leakages, over conventional bladed disk assemblies. However, the one-piece nature of the IBR results in low inherent structural damping and an increased susceptibility to high cycle fatigue (HCF) failures. Additionally, compressor variable vanes and stators also experience HCF field failures.

The continued development and application of new design tools and component technologies to mitigate HCF risk are necessary for rotating and non-rotating airfoils in compression system applications. An approach to mitigate this risk is the introduction of structural damping via thin (< 0.005 inch) coatings applied to the airfoil pressure and/or suction surface to reduce airfoil flutter and resonant stress. In addition to developing and demonstrating the damping coating, a methodology to predict the coating damping performance considering (but not limited to) airfoil mode shape, driver strength, environment, coating thickness, and coating placement must be developed and validated.

PHASE I: Demonstrate concept feasibility with titanium specimens. Specimen tests should evaluate the damping coating effectiveness for both low- and high-order modes for engine representative stresses and temperatures. Demonstrate the influence on material fatigue strength and erosion resistance via specimen testing.

PHASE II: Apply the selected coating system to an engine blade or integrally bladed rotor sector model demonstrated in combined load (multiple R-ratios) bench shaker tests. Complete high cycle fatigue spin durability testing to demonstrate the long-term durability of the coating system. Develop and validate the design method. Demonstrate the coating manufacturing and application methods for engine-sized components.

PHASE III: Analyze a set of engine-quality airfoils and design a coating system for the selected airfoils using the design methods produced and validated in Phase II. Application of the damping coating system will be followed by engine demonstration utilizing an existing test asset provided by industry and or a government agency.

PRIVATE SECTOR COMMERCIAL POTENTIAL: High-cycle fatigue is a significant issue for both military and commercial compression system airfoils. The transition to commercial engines is simplified by their less rigorous mission and thermal requirements.

REFERENCES:

1. MIL-HDBK-1783B, Department of Defense Handbook, "Engine Structural Integrity Program," 15 February

KEYWORDS: Airfoil; Damping; Vibration; Testing; High-Cycle Fatigue; Jet Engine

N04-020 TITLE: Innovative Materials and Designs for Joint Strike Fighter Lift Fan Drive Shaft

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop and demonstrate a composite material drive shaft able to perform at high torque and speed, and reduce high-cycle fatigue (HCF).

DESCRIPTION: The current design and materials for the F-35 short takeoff/vertical landing (STOVL) lift fan drive shaft are presenting significant drawbacks with regard to weight and HCF. This shaft must be capable of enduring extremely high torque and rotational speeds. The vibration modes associated with these high rates of rotation will cause fatigue in the shaft, shortening its service life considerably. Therefore, there is a need to develop a drive shaft from a material that can help reduce the overall weight of the lift system and exhibits the characteristics of heavier materials. Developing a drive shaft capable of allowing more than one-degree misalignment, while loaded, and more than two degrees unloaded, without increasing weight, would extend the service life of the drive shaft drastically.

The current lift system design requires the drive shaft to rotate at an extremely high rate between 5,000 and 8,500 RPM. This results in maximum vibrations of approximately 5 inch/sec (ips) at the clutch coupling and 4 ips at the engine fan coupling. The shaft is also required to transfer nearly 28,000 shaft-horsepower (HP) to the clutch and lift fan. There has been limited research into using advanced materials for the drive shaft, although the benefits to the F-35 STOVL configuration would be substantial. The development of this component would provide considerable advantages to the life-cycle of the lift system.

PHASE I: Demonstrate the technical merit of the proposed design and materials to meet operational parameters. Consider advanced materials capable of meeting the JSF lift system requirements and exceeding the life-cycle requirements of current drive shaft design.

PHASE II: Develop a prototype drive shaft. Demonstrate the durability and strength of the drive shaft material and design and show the characteristics of the drive shaft under high torque and HCF loads. Determine the life-cycle effects of the drive shaft on the lift system.

PHASE III: Transition the prototype drive shaft and field test it with an actual JSF lift system. Demonstrate overall weight savings and the effect of the redesigned drive shaft on total aircraft performance in STOVL.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology developed could be applied to countless commercial aircraft systems. This product would help decrease the propulsion system weight making it a very useful product to many other systems where weight reduction could be beneficial to the life cycle of the system.

REFERENCES:

1. Bevilaqua, Dr. Paul. "Development of Shaft Driven Lift Fan Concept." International Powered Lift Conference Proceedings, pp. 319-340.

KEYWORDS: Drive Shaft; High-Cycle Fatigue; Weight Reduction; Lift System; Composite; Materials

N04-021 TITLE: Development of Gas Turbine Augmentor Testing Procedures

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop and implement nonobtrusive testing for a gas turbine augmentor.

DESCRIPTION: Major changes in high-performances gas turbine augmentors have obviated the current design system. These changes have hastened traditional technical challenges such as flame holding, efficiency, and screech/rumble. A new design system for these advanced augmentors will consist of models based on physics and statistical information and will be required to reduce cost, schedule, and risk.

Instrumentation will be required to obtain data such as temperature, species, radicals and heat release in the augmentor near the flame holders. The data will have to be taken in-situ. Nonintrusive techniques will be ideal for this type of application. Data will also be required at many points in the flow at the same time. Time dependant data will also be required to understand the temporal nature of the processes in the augmentor.

Several optical diagnostic techniques have been further developed to enable them to obtain required data at augmentor conditions. A few of these techniques include line-of-sight absorption for concentration and temperature measurements and multi-beam techniques such as coherent anti-Stokes Raman scattering (CARS) and transient gratings for point temperature measurements. Diode-laser-based absorption measurements can be made using telecommunication-grade components at kilohertz frequencies. Water vapor concentration and temperatures are now routinely measured in harsh combustion environments.

PHASE I: Demonstrate the feasibility of a mature diagnostic. The diagnostic should be capable of measuring as many of the following as possible; H_2O, CO_2, CO, temperature, OH^+, CH^+, and heat release. The diagnostic should, as a minimum, be able to take time resolved data in the 50-kHz to 100-kHz range. The measurement should be demonstrated in an atmospheric combustion rig (combustor or augmentor).

PHASE II: Develop and demonstrate the concept to the point where measurements can be conducted in augmentor rigs at relevant conditions. Pursue issues of commercialization and packaging to ensure a diagnostic that is simple to apply, simple to derive data from, and portable to a large extent.

PHASE III: Research alternate applications of this equipment. Refine the testing techniques so that they can easily be adapted for similar testing situations in other gas turbine augmentors.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Technology developed from this research may have application to testing of combustion chambers and turbines used in industrial power plants. It may also have potential in future aerospace applications such as high-speed civil transport.

REFERENCES:

1. Zhou, X., Liu, X., Jeffries, J.B., and Hanson, R.K. "Diode Laser Sensors for Combustion Control." Paper AIAA 2003-1010 at 41st Aerospace Sciences Meeting, Reno, Nevada, January 2003.
2. Mattison, D.W., Oehlschlaeger, M.A., Jeffries, J.B., and Hanson, R.K. "Pulse Detonation Tube Characterization Using Laser Absorption Spectroscopy." Paper AIAA 2003-0713 at 41st Aerospace Sciences Meeting, Reno, Nevada, January 2003.
3. Brown, M.S., Li, Y., Roberts, W., and Gord, J.R. "Analysis of Transient-Grating Signals for Reacting-Flow Applications." Appl. Optics, #42, 2003, pp. 566-578.
4. Brown, M.S., and Roberts, W.L. "Single-Point Thermometry in High Pressure, Sooting, Combustion Environments." Journal of Propulsion and Power, #15, 1999, pp. 119-127.

KEYWORDS: Augmentor; Temperature; Species; Radicals; Heat Release; Nonobtrusive Testing

N04-022 TITLE: Airborne and Air-Deployed Multi-Sensor Search Optimization

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Air ASW Systems

OBJECTIVE: Develop the capability to optimize over-water and over-land searches for multiple stationary and moving targets conducted using multiple sensor technologies either on or deployed from maritime patrol aircraft and unmanned air vehicles.

DESCRIPTION: The most common practice for planning antisubmarine warfare (ASW) search operations (a legacy of deep-water World War II submarine-hunting strategy) is to use sensor performance predictions based on historical environmental data (sometimes enhanced by a few in-situ measurements) and from them calculate the "R50 range-of-the-day," i.e., the estimated range where the probability of detection is 50 percent. A single ship steams along ladder tracks spaced at twice R50 or an aircraft lays a standard sonobuoy pattern with spacing of 1.5 times R50.

However, search operations are now required and conducted in near-shore, littoral regions (where water and sediment properties and local oceanographic features are very complex) and onshore regions (which are even more complex) for many more target types than in the past. Environmental complexity can cause R50 detection ranges to vary dramatically from point to point and in various directions from a single point, thus violating the homogeneous, isotropic assumptions underpinning standard tactics. Legacy ladder search patterns and equally spaced sonobuoys tend to significantly under-perform in comparison with more advanced search planning concepts in complex environments because they allocate effort nonoptimally; i.e., too much effort in some areas and too little effort in other areas.

Modern reconnaissance aircraft typically carry a variety of sensors on board and can deploy other sensors at will (until the supply is exhausted). These sensors often have dramatically different sensitivities at different altitudes and under different meteorological conditions: what is good for sensor A is marginal for sensor B and precludes use of sensor C. These sensitivity envelopes also vary depending on the target being searched. Unsurprisingly, it is very difficult for even an expert tactician to provide an optimal search plan for a single target in a complex area or a variety of targets in a simpler area, and almost impossible for multiple targets using multiple sensors in a complex area.

The Navy is seeking algorithms that can integrate several types of information and form near-optimal search plans. Algorithms must interface with networks to gather information from accurate range-dependent sensor prediction tools for a variety of acoustic and nonacoustic sensors using real environmental data under a variety of flight conditions (altitude, airspeed, etc.) They must accurately account for mutual interference problems when sensors operate simultaneously. They must also account for platform location, capability (speed, ability to turn, sensors carried, etc.), and availability (e.g., deployable sensors such as sonobuoys are limited to storage capacity). The algorithms' objective function (their measure of effectiveness (MOE) such as maximized cumulative probability of detection, minimized time elapsed to meet a detection probability threshold, maximized probability of survival, etc. and combinations thereof) must be general (i.e., not hardwired), so that the user can tailor them to suit present needs. Consideration should be given to true probabilities to prevent double counting of detections; various target characteristics; expected distributions in the search area; likely behavior of each once it detects the attempt to search for it. The algorithms must perform these tasks for any arbitrary set of targets conjointly.

PHASE I: Design a conceptual approach, with sufficient mathematical, operations analysis, and statistical support, that contains a variety of sensor types and mission parameters. Simulate sets of controlled, but realistic, sensor performance data and evaluate the validity of the proposed concept. Show the value of optimal search planning and the need for joint sensor usage.

PHASE II: The design must be compatible with ongoing Navy software architecture goals under the Seapower 21 vision. Build a prototype tactical decision aid system that exploits environmental, sensor, and threat information to make maximal use of available sensors. The prototype system should be moderately user-friendly and contain innovative displays that facilitate the decision process.

PHASE III: Enhance the system for efficiency, integrate it with naval coastal warfare architectures, and improve the interfaces to allow use and evaluation by Fleet operators in a laboratory environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Applications of this technology include commercial fishing, search and recovery missions, ocean monitoring, seismic studies, mineral prospecting, and oil exploration.

REFERENCES:

1. Koopman, B.O. Search and Screening. Operations Evaluation Group Report 56, Navy Department, 1946. Reprinted (with additions) as Search and Screening: General Principles with Historical Applications. Pergamon Press, 1980.
2. SEAPOWER 21 Vision, Offices of: Chief of Naval Operations, Secretary of the Navy, and Commandant of the Marine Corps, 2002.
3. Common Undersea Picture Top Level Requirements Document, Revision 15, October 2002 (PEO(IWS5)).

KEYWORDS: Search Planning; Decision Aids; Acoustic Sensors; Nonacoustic Sensors; Bayesian Statistics; Data Fusion

N04-023 TITLE: Repair Process for Ion Vapor Deposition (IVD) Aluminum

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop a method to repair damaged IVD aluminum coatings.

DESCRIPTION: Currently, the only repair process for IVD aluminum is brush cadmium plating. Due to the toxic and cancerous nature of cadmium, the method is not used at many Fleet locations, leading to inadequate repairs of damaged IVD aluminum coatings. A less hazardous repair method and coating are desirable to restore the performance of the damaged coating to its original state. This is especially critical on high-strength steel surfaces where IVD aluminum is typically used. The new coating must meet or exceed the performance of the coating it repairs, be compatible with the substrate and adjacent materials, and provide an adhesive base for subsequent organic coatings.

PHASE I: Develop one or more nonhazardous coating formulations that meet current environmental laws/regulations and coating process and performance requirements at Navy maintenance levels. Conduct preliminary laboratory testing to demonstrate the feasibility of the new formulation(s).

PHASE II: Further develop a new coating system. Conduct both laboratory testing and preliminary field evaluations. This testing must demonstrate that the new coating meets all the performance requirements and environmental laws/regulations for application.

PHASE III: Refine and produce the economically viable coating system demonstrated in the Phase II effort for both the military and commercial market. Further field evaluation may be required.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The new coating system can be used on commercial aircraft as well as non-aerospace applications for both the government and private sector.

REFERENCES:

1. MIL-DTL-83488D, Detail Specification, Coating, Aluminum, High Purity dated 1 April 1999
2. Joint Cadmium Alternative Project, Project No. J-00-MF-024, http://www.jgpp.com/projects/projects_index.html

KEYWORDS: Cadmium Replacement; Sacrificial Coating; Brush Plating; Electroplating; Repair; Nonhazardous Pollutant

N04-024 TITLE: Strong Location-Specific Authentication for Mobile Users and Devices

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Design, build, and demonstrate a means to implement strong authentication between two parties (end-to-end) in a wireless data environment where one or more parties is moving or mobile.

DESCRIPTION: Advances in signal strength and throughput of wireless data networks, coupled with a significant reduction in size and cost, will cause the mobile computing and communication environment to grow dramatically in the immediate future. Today's conventional security systems rely upon three credentials ("something you have," "something you know," and "something you are"), coupled with device name and IP address restrictions, for the authentication of a person or device at the other end of a point-to-point connection (such as over the Internet.) Unfortunately, it is a relatively easy matter to break the security of a wireless communication system since its very success depends on relatively free and easy access to the radio frequency signals. Consequently, these signals can be intercepted and then used by other wireless parties to "masquerade" as legitimate users.

In a highly fluid environment such as that experienced by warfighters, or between two moving objects such as a ship and a tactical aircraft, two or more parties need to remain mobile yet communicate securely without fear of interception or spoofing. Authentication of identity must extend beyond conventional security layers to include location-specific signatures that attest to the veracity of a user. These location-specific signatures, however, must be secure in themselves, in that they cannot require the active presence of conventional geo-location technologies (such as global positioning systems) in order to authenticate a user, since systems such as this can easily be jammed or otherwise rendered unavailable.

This SBIR topic seeks to address the security holes present in a wireless environment so that two entities attempting to communicate with one another through wireless means can authenticate themselves using conventional security protocols strengthened with signatures that are related to their geo-location history (for example, "where have you been" and "where are you now"). The proposed system is intended to enable strong authentication of users so that, if required, their identity and real-time geo-location can be validated to a high level of assurance for purposes of access control, non-repudiation, etc. The proposed system should also eliminate vulnerabilities in other security systems and add further strength to biometrics and public key infrastructure. This information should also enable the wireless network system operations to securely obtain, if desired, complete information awareness regarding the real-time geo-location of the network's users.

PHASE I: Determine the technical feasibility of implementing strong location-specific authentication between two parties where at least one party is moving. This includes identifying concepts and methods related to location-specific authentication and providing preliminary measurement results that substantiate the assertion of location-specific unique signatures.

PHASE II: Develop, demonstrate, and validate a prototype system in a realistic wireless and mobile environment. Conduct red-team testing to prove scalability and robustness. Implement the selected location-specific strengthening of authentication credentials in a limited field test to provide strong authentication of mobile users and devices without a concern about denial of access due to lack of local or remote signature signals.

PHASE III: Deploy the technology to provide strong defense of a mobile network in a real operational theater.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The growth of wireless applications is inhibited today by concerns about security, fears of interception or eavesdropping, and an inability to authenticate sufficiently for purposes of non-repudiation. Successful demonstration and deployment of the proposed system will allow secure wireless communication between mobile parties with assurance that the identity of the other party is truly trusted and cannot be compromised. Sectors that seek this assurance include, but are not limited to, critical infrastructure (e.g., power grid, aviation), healthcare (privacy concerns surrounding medical records), financial services (online banking and e-commerce), and confidential corporate communications. Each of these sectors will benefit directly from the strong authentication layer that the proposed system is uniquely capable of providing.

KEYWORDS: Authentication; Location; Wireless; Awareness; Security; Nonrepudiation

N04-025 TITLE: Laser Repair of Compressor Blades

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop an innovative process for repairing turbine engine airfoils damaged by erosion, foreign object debris (FOD), or other causes.

DESCRIPTION: The leading edges of compressor airfoils, both on individual blades and integral rotors called "blisks," are subject to varying degrees of damage depending upon their service environment. In many harsh conditions, blade leading edges eventually lose their aerodynamic shape and compressor efficiency suffers accordingly. Restoration of the blades to their original contour provides a cost-effective way to reclaim worn parts. Repair methods must not degrade original parent metal properties. A low-heat metal deposition process is required that will not adversely affect the material strength in the heat-affected zone, while providing high-efficiency bond strength.

PHASE I: Demonstrate the technical merit of the proposed repair process by performing metallographic and mechanical property testing on simulated blade coupons of selected material types. Investigate post-weld machining.

PHASE II: Repair the engine airfoils and blisks of various material types using the innovative process. Perform metallographic and mechanical property testing to prove the capability of the repair process for selected applications. Investigate post-weld machining.

PHASE III: Transition and productionize the airfoil repair process to engine lines while working with the original engine manufactures and Navy Engine Airfoil Center.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial aircraft engine manufacturers will be able to directly transition this technology to their commercial engine repairs, as well as to their military lines.

KEYWORDS: Repair; Laser; Weld; Airfoil; Engine; Blisks

N04-026 TITLE: Aircraft Carrier Catapult Cylinder Slot Gap Measurement

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Aircraft Launch and Recovery Equipment

OBJECTIVE: Develop an easily portable, reliable, and accurate system of measuring catapult cylinder "slots."

DESCRIPTION: An aircraft carrier (CV or CVN) has four steam-powered catapults used to accelerate aircraft from a standing position to speeds sufficient for forward flight in about 350 feet. Each steam catapult is made up of two cylinders. A piston, powered by steam, is accelerated through each cylinder. (Cylinder diameter varies by ship type; CV(N)s 63-71 cylinder are 18-inch diameter while CVNs 72-76 are 21-inch diameter). These pistons are connected to the shuttle, which in turn is connected to the aircraft. Each row of cylinders is broken up into 12-foot sections. The cylinders have a gap in the top (cross-sectional view: 12:00 position) to allow for a connection between the pistons and the shuttle. This gap is known as the slot. The slot width is a key component of the maintenance of the catapult. If the slot width is too large or too narrow, there may be "binding" of the catapult system, which could, potentially, cause the cessation of flight operations or ship movement until new equipment is installed. Slot width measurements need to be accurate within ±0.001 inch over the 350-foot distance. The slot can only be accessed through either the end of the cylinder run in a tight location or the catapult must be disassembled.

Additionally, the slot and the cylinders it traverses will be covered in significant amounts of oil and residual lubricant.

Currently the slot is measured two to three times per year using one of two methods: 20-year-old, unreliable and cumbersome “gap gear” or by hand. The gap gear is a precision measuring system that takes measurements of the slot at only five different locations along each cylinder section. (Measurements are taken six inches from either end of the cylinder, and at three feet, six feet, and nine feet). Driven by a motor, it is connected by a large array of cables that supply power and enable communication with the unit. When this unit is unavailable, inoperable, or a discrepancy in the measurements is found, the slots must be measured by hand. This requires a near-complete disassembly of the catapult system. This process is extremely time consuming and manpower intensive and is subject to error due to the breakdown and reassembly of the system. As slot measurements are not only taken when the ship is in its homeport but may be taken anywhere in the world, the ability for a technician to easily transport the equipment via commercial airlines is imperative.

PHASE I: Demonstrate the feasibility of the proposed concept to perform measurements within the required tolerances (±0.001”). Demonstrate the capability to traverse the distance of the catapult with the proposed measurement tool and to record measured data in a spreadsheet format. The selected company will either visit an aircraft carrier or the cylinder will be made available to the company so that it becomes familiarized with the equipment to be measured.

PHASE II: Develop and produce the prototype hardware and use existing catapult cylinders to demonstrate its ability to perform and verify the slot measurements within required tolerances and saved in a spreadsheet format. Demonstrate the ability to assemble all required gear from commercial air containers on the flight deck of an aircraft carrier with only one technician.

PHASE III: Develop a training plan, training manuals, and maintenance routine. Transition the tool to the Fleet.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology may be applicable anywhere where tight tolerances are required. Measuring track alignment for high-speed trains, future magnetic levitation trains and monorails, power plant piping, and gun barrels are industries where small tolerances over a long distance might be required.

REFERENCES:

1. Technical Manual. "Operational and Intermediate/Depot Maintenance with Illustrated Parts Breakdown, Cylinder Gap Indicating System." NAVAIR 51-15ABC-6, Change 1 ¾ 1 April 2001.

KEYWORDS: Catapult; Cylinder; Measurement; Aircraft Carrier; Slot; Launch

N04-027 TITLE: A Fidelity Analysis Tool for F-35 Joint Strike Fighter Training Systems

TECHNOLOGY AREAS: Information Systems, Human Systems

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop innovative procedures and software tools that will aid in the instructional system design (ISD) of simulators to include the selection of the most appropriate levels of fidelity for the training devices and the process by which the simulator specification will be developed, based on training objectives.

DESCRIPTION: Development of training systems requires an extensive review of the goals and objectives, the needs of the user, the level of realism necessary, the environment in which the system(s) should operate, and the cost involved. In developing the F-35 JSF, much emphasis is being placed on creating the most efficient training system at the most affordable cost.

The term "fidelity" can be defined as “a formal description of the level of realism a model or simulation must display in order to achieve or to fulfill (sic) the needs and objectives of the user of the model or simulation (Roza et.

al.).” To meet the cost constraints of the F-35 JSF program, the fidelity of the system needs to be analyzed in a way that provides the design team with a reliable, accurate measure of fidelity for the training device. This information can then be used to specify the requirements of the simulators and all other devices to be implemented in the F-35 program.

A tool that will analyze fidelity needs of a training system accurately does not currently exist. This tool would provide valid, reliable, and accurate information to meet the needs of instructional design professionals who are interested in utilizing appropriate levels of fidelity. Some of the problems that need to be addressed are to define the optimum level of data input to the fidelity analysis steps in terms of training requirement definition. Second, a model and toolset need to be produced that will automate the fidelity selection process, accounting for a full range of likely training tasks (i.e., pilot and maintainer) for psychomotor and cognitive task requirements, and for different levels of fidelity required at different stages of training (i.e., novice versus expert students).

PHASE I: Conceptualize and design an innovative software tool and procedure that will guide training analysts in the selection of the most appropriate levels of fidelity for the training device; make explicit the process by which the simulator specification will be developed from training objectives; and is compatible with existing ISD and engineering activities.

PHASE II: Develop, demonstrate, and validate the software tool and accompanying literature based on accepted design specifications. Evaluate the software tool for accuracy and reliability.

PHASE III: Upon meeting Navy requirements, install the software tool, provide training in its use, and oversee the initial implementation of the tool and its manuals to correct any problems that may arise in the program.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A fidelity analysis tool can be implemented in any industry using training devices for skill acquisition. Commercial industries include but are not limited to commercial/corporate aviation, the gaming industry, and medical/surgical professionals. Nonmilitary aviation communities using training devices will benefit from this tool as well.

REFERENCES:
1. Roza, M., Voogd, J., Jense, H., Van Gool, P. "Fidelity Requirements Specification: A Process Oriented View." http://www.tno.nl/instit/fel/ebf/publicaties/99F-SIW-032.pdf

KEYWORDS: Fidelity; Skill Acquisition; Aviation; Training; Analysis; Simulators

N04-028 TITLE: <u>Modeling, Simulation, and Other Techniques to Verify and Validate Prognostic and Health Maintenance (PHM) Capabilities</u>

TECHNOLOGY AREAS: Air Platform, Information Systems, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop innovative demonstration and evaluation tools, and modeling, simulation, and other techniques that would enhance the ability to accurately and confidently verify and validate PHM capabilities.

DESCRIPTION: The JSF program is developing a robust and comprehensive PHM capability across all subsystems that will be highly integrated into the air vehicle and air system design. This is a companion topic to the development of models to understand fault-to-failure progression rates. Previous efforts have been aimed at developing prognostic and diagnostic models to address incipient fault-to-failure progression characteristics for the component and/or subsystem of interest. This effort will develop, demonstrate, and apply advanced techniques, methodologies, and modeling and simulation approaches in support of verifying and validating of PHM capabilities.

PHASE I: Define the techniques, methodologies, and approaches needed to verify and validate PHM capabilities. Develop a strategy for integrating the required detection and modeling and simulation components. Demonstrate the feasibility to develop the advanced models, techniques, and other application programs required.

PHASE II: Develop and demonstrate a prototype or set of prototypes for these advanced models, simulations, techniques, and programs to improve verification and validation capabilities. Assess PHM capabilities more effectively and efficiently. Assess the application boundaries, accuracy, and limitations for these modeling techniques.

PHASE III: Develop, validate, and deliver a complete set of application modeling programs and techniques to be used on several aircraft systems. Integrate these capabilities within a comprehensive program for verification and validation of all PHM system capabilities for the JSF application.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Any results (understanding) gained from applying these modeling and simulation techniques and other improved verification and validation techniques would provide a significant crossover benefit to other similar applications, commercial or military.

REFERENCES:

1. Henley, Simon, Currer, Ross, Sheuren, Bill, Hess, Andy, and Goodman, Geoffrey. "Autonomic Logistics—The Support Concept for the 21st Century." IEEE Proceedings, Track 11, paper zf11_0701.
2. Byer, Bob, Hess, Andy, and Fila, Leo. "Writing a Convincing Cost Benefit Analysis to Substantiate Autonomic Logistics." Aerospace Conference 2001, IEEE Proceedings, Vol. 6, pp. 3095-3103.
3. SAE E-32 Committee Documents.
http://forums.sae.org/access/dispatch.cgi/TEAE32_pf/showFolder/100001/def/def/3f4f
4. IEEE Aerospace Conference Proceedings for 2001 and 2002 Track 11 PHM

KEYWORDS: Diagnostics; Prognostics; Modeling; Failure Prediction; Forecasting; Condition Maintenance

N04-029 TITLE: <u>Assessing Useful Remaining Life of Lithium (Li)-Ion Batteries After Deep Discharges</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes

ACQUISITION PROGRAM: Joint Strike Fighter (JSF)

OBJECTIVE: Develop the necessary algorithms to determine the useful remaining life of li-ion batteries after a deeper than nominal discharge (discharge less than 2.0 volts/cell). The algorithms should augment those necessary for normal operational cycling.

DESCRIPTION: Li-ion batteries can be virtually destroyed in as little as a single complete discharge. At the relatively shallow discharges intended for normal applications, li-ion batteries have demonstrated exceptionally long cycle lives. To make best use of the technology within the JSF prognostics and health management (PHM) and Autolog architecture, the rate at which useful life is degraded by depth of discharges including those that exceed normal operations needs to be better understood and characterized to implement health management, prognostics, and opportunistic just-in-time maintenance.

PHASE I: Perform a feasibility study on whether remaining useful life algorithms can be augmented by accounting for depth and duration of discharges beyond normal ranges (less than 2.0 volts per cell). Document prototype remaining useful life model parameters necessary to recharacterize current battery health assessments as well as future health predictions based upon depth and duration of discharges experienced during shipping, storage, or abnormal operating conditions. Develop a strategy for collecting information required to update battery health status after deep and lengthy discharges during shipping, storage, or abnormal operating conditions.

PHASE II: Develop and document air vehicle (AV), battery, and Autolog parameters and interfaces necessary to recharacterize battery current and predicted health status based upon shipping, storage, or abnormal operating conditions. Develop the detailed remaining useful life models to account for depth and duration of discharge beyond nominal levels. Conduct cycle testing of representative cells or batteries to determine remaining useful life as a function of depth and duration of discharges beyond nominal. Verify that the data collection strategy can be implemented and that data can be applied to update battery health status within the overall JSF architecture.

PHASE III: Develop necessary AV, battery, and Autolog parameters necessary to identify when batteries have been subjected to abnormal discharges. Implement the data collection strategy necessary to feed the algorithms with abnormal discharge information. Implement updated remaining useful life algorithms that address abnormal discharges by making any necessary modifications to on-board and off-board software modules within PHM and Autolog.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology is applicable to any military or commercial application of lithium-ion batteries.

KEYWORDS: Condition Based Maintenance; Diagnostics; Prognostics; Lithium-Ion; Batteries; Deep Discharge

N04-030 TITLE: New High Temperature Pavement Joint Sealants

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a completely new (not commercially available), liquid or gel applied, polymer composition to seal the pavement joints on concrete airfield pavements exposed to heat at 700° F or higher.

DESCRIPTION: Commercial coal tar, polysulfide, and silicone sealants are currently used as airfield pavement joint sealants. Joint sealants are used to prevent water and solid debris from entering the joint and weakening the pavement sections. For example, water may freeze to form ice that expands and cracks the pavement. Other debris may enter the joint and cause edge cracking of the pavement, which increase the chance of "foreign object damage" (FOD) that could damage expensive aircraft engines.

Commercial sealants are generally useful up to about 500°F, but they tend to melt or decompose when heated by take-off and landing (VTOL) aircraft. Some of the VTOL aircraft may heat the pavement momentarily to 700°F or higher, for short periods of time. The proposed effort requires the development of a new class of sealant materials. The polymers would meet the basic chemical and physical requirements of other pavement joint sealants (elasticity, elongation, solvent resistance, water repellency, and resistance to sunlight ultraviolet, air oxidation, and microbial attack) but also be thermally resistant at the high temperature end. Several high temperature polymers are commercially available, but the cost is prohibitive.

PHASE I: Develop and test a new, non-silicone polymer product or formulation for short term (three minute exposure) heat exposures in the range of 700°F or higher. Provide a rationale for synthesis, compounding or formulation of the new sealant. The sealant should have the properties of a curable gel or liquid. Indicate the chemical class or composition of the polymer or formulation. Perform thermal and chemical resistance tests on the new sealants and compare to other commercially available sealants at temperatures ranging from 500° F to 600° F. Identify the decomposition products of the new polymer sealant when heated above the decomposition temperature. The new elastomeric product should be a liquid or gel that solidifies in 4 hours and completely cures in 24 hours or less at 70°-75° F. The joint sealant should designed and formulated for long term use (15 years or more) on concrete pavements exposed to hot and cold temperatures, sunlight UV exposure, wind, rain, snow, high humidity, air oxidation, microbial organisms (fungus, yeasts, molds, bacteria), marine climates (salt spray) and hot, dusty conditions (deserts). Describe how the sealant will be produced in quantity and provide a marketing plan for production and distribution.

PHASE II: Test sealants in different climate zones. Apply the new polymer formulation to those airfields that currently test the V-22 aircraft. Design tests so that the sealants are actually exposed to aircraft engine exhausts at pavement temperatures in the range of 700°F or higher, to also accommodate the developing joint strike fighter (JSF). Set up and calibrate temperature measurement systems to validate the tests. Provide a plan for statistical analysis of the data. Determine the number of heating and cooling cycles at which the sealants can be exposed at these temperatures (3- minute heating times). Measure and record the actual pavement temperatures during aircraft exhaust exposure. Provide sufficient details on the performance of the new polymer sealants in comparison with conventional sealants. Compare the characteristics and costs of the new joint sealants with currently used joint sealants. Prepare a mathematical model to extrapolate the expected number of cycles, over a 15-year period, based on short-term (1-year) field test data. Prepare a plan for production and marketing of the materials and identify the manufacturers and distributors. Determine the production costs. Indicate what arrangements have been made with manufacturers to produce and distribute the polymer sealant. Prepare return on investment (ROI) data to demonstrate that the sealant is cost effective. Calculate the “break even” period (years of service) for this sealant, based on industry standards.

PHASE III: Prepare user data packages and specifications for the new joint sealant material. Prepare manufacturing package and determine the cost of the material on a large scale (at least 500 gallons of product). Determine costs of packaging, compliance with federal safety and health laws, and disposal costs. Demonstrate realistic cost-savings or return on investment ratio (ROI) of at least 5:1 for these sealants, over a period of at least 10 years. Identify any gas decomposition products and temperatures when the polymers are heated at temperatures of 700°F or higher. Determine the volume (per mass of polymer) of the gases and report on the toxicity. Report on any environmental issues involving decomposition of the products. Provide details on how possible air pollution issues would be resolved with federal, state and local environmental departments (such as the EPA).

PRIVATE SECTOR COMMERCIAL POTENTIAL: The new material could be used for both domestic (civilian) and military airfields. The new sealant might also be used for highways, roads, and bridge decks.

KEYWORDS: Polymers; Elastomers; Pavement Sealants; Synthetic Rubbers

N04-031 TITLE: Heat Recovery System for Discharged Hot Water into the Sewer System

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a cost effective small domestic use heat recovery unit for hot water discharge from sewer system from sinks, showers, and laundry rooms. System should reduce energy consumption by 15 per cent.

DESCRIPTION: Present Heat Recovery units are cylindrically shaped measuring about 3 feet in length. These units are connected to drains (Sinks, showers, laundry, etc.) where hot water is discharged into the sewer system. Each year the Navy consumes natural gas and electric power for domestic water heating (this includes sinks, showers, and laundry rooms). This hot water is discharged into the residential and commercial sewer system after use. Recovering and using discharged hot water to pre-heat water for conventional water heaters will decrease the amount of natural gas and electric power consumed by the Navy for water heating. Currently, there are heat recovery units commercially available but because of bulk and volume they are not suitable for either retrofit or new construction. In most cases, they are too long in length (over 3 feet) to be applied for many construction projects.

PHASE I: Develop concepts for decreasing the overall length of heat recovery systems for discharged hot water and to use this recovered heat to per-heat water for conventional water heaters. Determine the feasibility associated with these concepts. The feasibility study shall indicate developmental costs, prototyping costs, production costs, and market prices for these new heat recovery systems.

PHASE II: Design, build, test, and evaluate prototype heat recovery systems. Develop plans for large-scale production or mass marketing.

PHASE III: Produce a packaged heat recovery system for commercial off the shelf procurement and a user data package to facilitate the use of these heat recovery systems throughout the Navy and Commercial Sector.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The commercial sector has to procure natural gas and electric power to heat water for domestic use. Using recovered heat from discharged hot water to pre-heat water for conventional water heaters will lead to the reduction of natural gas and electric power purchases for domestic water heating. Reducing energy costs of commercial facilities will enable the commercial sector to use the resulting dollar-savings to re-capitalize other aspects of their operations and pay for needed capital improvements. The commercial sector has on-going construction and retrofit projects which could benefit from this technology. However, the physical size and length of currently available heat recovery systems (over 3 feet) make it difficult for the commercial sector cannot make use of this technology for their on-going construction and retrofit projects.

KEYWORDS: Heat Recovery; Energy Efficiency; Energy Management; Water Heating; Hot Water Systems; Energy Conservation

N04-032 TITLE: New Non-Silicone Airfield Joint Sealant for General Use

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a reduced cost, high performing, two component, self leveling, polysulfide modified epoxy, airfield joint sealant that exceeds the requirements of the Federal Specifications and the Unified Facilities Guide Specifications (UFGS).

DESCRIPTION: The preferred general use airfield joint sealant is a single component silicone due its outstanding heat, jet blast, and sunlight resistance. However, silicone sealants are relatively expensive (≈$53.00/gallon) and can display unsatisfactory seal when subjected to continuous spills from jet fuels, lubricating oils, and hydraulic fluids. In general, polysulfide materials are known for outstanding chemical resistance to fuels, excellent weather ability, and superior flexibility: epoxies are low in cost and tend to display maximum substrate adhesion, high chemical resistance to both hydraulic fluids and oils, and can be cross linked for greater flexibility. As such, the development of a general use polysulfide modified epoxy airfield sealant should improve sealant chemical resistance, decrease the frequency of maintenance sealing, and reduce total ownership costs. Experience indicates that the general use sealant should exceed the following approximate requirements: 1) Federal Specification SS-S-200E, “Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold Applied, For Portland Cement Concrete Pavement,” and 2) Unified Facilities Guide Specification (UFGS) – 02982N, “Resealing of Joints in Rigid Pavement” for the “Single Component Cold-Applied Silicone.” Interested proposers should have previously demonstrated their capability for commercialization and production either by in-house or joint venture partnering. Interested proposers should have the corporate (in-house or joint venture) capability of commercial marketing and production. Preferred offerors are those who currently manufacture industrial sealants for use by the concrete pavement industry.

PHASE I: Develop a general use polysulfide modified epoxy sealant for use in the sealing of airfield concrete pavements.

PHASE II: Refine, test and field demonstrate the polysulfide modified epoxy sealant developed under the Phase I effort. Demonstrate by standard Industry practice that the sealant exceeds the acceptable sealant performance criteria for accelerated aging, self-leveling, change in mass by fuel immersion, change in volume on exposure to elevated temperature, resilience, artificial weathering, bond to concrete, flame resistance, flow, storage stability, tack free time, hardness, tensile strength, percent elongation, weight loss, ease of application, bond and movement capability, and toxicity, as defined in Reference 3. For the sealant draft a new Product Data Sheet (PDS) detailing material properties and application procedures. Field demonstration through simulated airfield joint sealing on no less than 2,000 LF of concrete joints.

PHASE III: Produce and market the sealant demonstrated in the Phase II effort. Sealant manufacturer will include this product and an improved PDS in their current list and/or catalogue of commercial products and further commercialize the sealant by advertising in a reputable airfield trade journal. The sealant will be procured by Naval activities through amendments to UFGS-02982N. Intended users are Navy, Army, Air Force, Marines, Bureau of Reclamation, and custodians of FAA airfields.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The general use polysulfide modified epoxy sealant could be employed on all DOD and FAA airfields.

REFERENCES NOTES:
1. Available at http://assist2.daps.dla.mil/quicksearch/
2. Available at http://www.ccb.org/ufgs/ufgs.htm
3. Unified Facilities Guide Specification (UFGS) ¨C 02982N “Resealing of Joints in Rigid Pavements.” Specific document is downloadable from the web sites listed above.

KEYWORDS: Joint Sealant.

N04-033 TITLE: Mixing Techniques for Diverse Control Effectors

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS450, ACAT I

OBJECTIVE: Enable optimal control of platform having multiple, diverse control effectors, such as control surfaces, ballast, thrusters, main propulsion, etc., through a control system providing the most advantageous mixing of the control effectors to provide automatic and operator-aided commands for precision control in constrained environments.

DESCRIPTION: Automatic ship control systems have become the norm in new platform--submarine and surface ship--designs. The platforms contain varying types of control effectors for different operations and operational regimes. Generally, the control systems for each type of control effector are designed independently of the others. When there is a need to operate more that a single type of control effector, the corresponding control systems are operated simultaneously, but are not necessarily complementary due to the different requirements to which they were designed. This effort would develop strategies for optimally mixing diverse control effectors.

PHASE I: Develop strategies for optimally mixing diverse control effectors. Develop a control system concept design using the mixing strategies for a combination of control effectors consisting of control surfaces/fins, thrusters, main propulsion, and ballast.

PHASE II: Build the optimal control system and test in a simulated or actual work environment.

PHASE III: Design, using the developed mixing control strategies, and build a flexible, full-scale control system for installation on commercial and military platforms. Commercial applications are discussed below. Examples of military platforms include submarines, surface ships, unmanned underwater vehicles, and sub-surface weapons.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The strategies and resulting system could be applied to a broad range of commercial platforms having multiple, diverse control effectors which must be optimally controlled for precision operation. Examples of these commercial platforms include, but are not limited to, deep-diving manned research vehicles, passenger craft including high-speed catamarans, off-shore installations with dynamic positioning systems, cargo transport craft including tankers, and unmanned underwater vehicles. Generally, each of these types of platforms includes a suite of diverse control effectors ranging from control surfaces/fins to lateral/vertical thrusting devices to axial propulsion units. Implementation of efficient control strategies can improve high speed vehicle safety, while enhancing low speed vehicle control precision.

KEYWORDS: Automation, control, submarine, effectors

N04-034 TITLE: Depth Control System for Fatline Towed Arrays

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

OBJECTIVE: Develop a depth control system that will provide greater operational flexibility when streaming the TB-16 series towed system in shallow water situations. The system must also be fully compatible with the constraints imposed by the SSN; the OK-276 handler, hull mounted stowage tube, and pressure hull mounted dynamic and static seals.

DESCRIPTION: Safe towing of TB-16 series towed arrays is constrained by the depth of the towed array vs. trail (amount of cable scope). When towing the system in shallow water, tow scope must be restricted (or in the limit, the array is not even allowed to be deployed) to ensure that the towed array does not drag on the bottom. However, short tow scopes position the array sufficiently close to the tow vessel such that own ship's noise detracts from the towed array’s performance. There are instances, however, where it is desired to have the array as far as possible below the ship, so that it may be below the “layer” while the ship remains above it, so it is desired, but not required, for the array trail depth to be variable for a given tow scope.

The present (legacy) systems are towed with a 0.375 inch diameter steel armored tow cable that is heavy and drives the depth vs. trail profile of the towed system. If the array or tow cable were made lighter it would give the submarine increased opportunity to use the towed array with greater tow scopes. This will improve the submarine's ability to exploit the acoustic environment in the Littorals in support of SEAPOWER 21, Sea Strike, and the global war on terrorism.

In addition, a shallower tow angle will reduce low frequency energy that is normally imparted onto the array by the strumming action that accompanies use of the heavy steel armored cable. This is a side benefit that will improve the towed array performance in all of its uses, not just a shallow water gain.

PHASE I: Develop a specification and candidate designs that addresses the cable tow profile, expected life when exposed to repetitive reeling cycles by the OK-276 handling system, and candidate termination design.

PHASE II: Develop prototype system designs. Designs will be evaluated and recommendations for improvements will be submitted as part of the final test report. The prototype design should demonstrate that it can meet the required strength, reliability, and performance specifications. Demonstrate the effectiveness of the prototype in a simulated at-sea environment.

PHASE III: A specification will be developed for final system design. A final system will be purchased for evaluation on board a SSN. The contractor will provide Design certification and Factory Acceptance Test procedures, which will be imposed on this first production cable. These may include tension-tension cycling, bend over sheave cycling, and reeling cycles on a GFE OK-276 test stand. The candidate approaches will be subject to tension-tension cycling, if appropriate, and a combined pressure and tension test, using GFE test facilities.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The experience gained in developing non-steel armored cables has application in the Seismic geophysical towed system area as well as the geophysical “down-hole” well drilling area. Lightweight cables capable of surviving the severe bending environment will have a longer life than conventional cables presently in use by the geophysical industry.

REFERNCES:
1. TB-16F Towed System PIDS (Prime Item Development Specification) (an unclassified excerpt of the relevant sections will be provided)

KEYWORDS: cable; Vectran; Kevlar; electro-mechanical; torque-balanced; towed array

N04-035 TITLE: <u>High Strength, Lightweight Lifting Device</u>

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PMS 435, ACAT IV.

OBJECTIVE: Develop a high-strength, light-weight, low cost, long life, composite material component for installation in submarine universal modular masts. The mast system components must meet all at-sea environmental operational requirements of submarines in both submerged and above water conditions. The current mast's main components consist of heavy guide trunks and fairing assemblies.

DESCRIPTION: Develop, fabricate and test a high-strength, lightweight, extracting and retracting component of the universal modular mast. Universal modular masts located in submarine sails house the critical Intelligence, Surveillance and Reconnaissance (ISR) systems.

PHASE I: Demonstrate the feasibility of developing and fabricating a high-strength, lightweight, low cost, corrosion resistant, composite mast system component. Develop high-strength non-metallic materials that will meet submarine environmental requirements while reducing weight and costs and increasing service life and reliability of submarine mast components. Design and perform an analysis of the performance of the mast component of NAVSEA Drawing No. 7225811 for compliance with shock requirements of Mil-STD-901D, under-water explosion (UNDEX) requirements, vibration requirements of Mil-Std-167-1 and reliable operations in seawater temperatures varying between -540 C to 850 C. Perform preliminary tests to verify the performance of the materials. Investigate economical manufacturing methods and provide a cost analysis.

PHASE II: Design and fabricate a full-scale, low cost, lightweight prototype of the universal modular mast guide trunk incorporating the design characteristics of Phase I and enabling a 30% minimum weight reduction of the existing material component. Conduct required testing to qualify the light-weight mast lifting component for at-sea use, for an extension range between 9ft and 36 ft at a speed no less than 1 ft per second. Determine reliable manufacturing processes to economically fabricate production masts in Phase III. Perform a detailed cost analysis of full scale production.

PHASE III: Design methods and materials developed during this project will provide for a lighter weight, lower cost, more reliable, longer life light weight lifting mast for use on submarines. Develop a plan to produce and incorporate the new light weight lifting mast into the fleet. Build prototype fairing assembly components and install them in a submarine for at sea testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Unmanned autonomous operated submersibles, off shore oil industry

REFERENCES:
1. MIL-STD-901D, Mil-Std-167-1, NAVSEA Guide Trunk Drawing 7225811

KEYWORDS: mast, lightweight, corrosion resistant

N04-036 TITLE: High Fidelity Data Management and Access

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: OPNAV N77, ACAT III

OBJECTIVE: Exploit advances in digital archival, data mining, and data quality/integrity management to support rapid access to data within large volume (multi-Terabyte) databases and to ensure accurate transcription and longevity of archived information.

DESCRIPTION: The annual amounts of archived data from modern naval combat system embedded data collection systems are increasing at an exponential rate. It is projected that within 2 years, submarine combat system recording alone will exceed 10 Petabytes (10 Million Gigabytes) per year. This enormous data volume places challenges to the user community in terms of data longevity and ease of access for the requisite years of storage. Media life is not the dominant problem, but the ability to index, access, and retrieve data from the media after even 2 years is problematic. The state of the practice in digital preservation must be employed, tailored, and applied to ensure that digital information of continuing value remains accessible and usable. Much of the tactical data collected on these embedded systems is used as the equivalent of a Flight Data Recorder. Modern data quality assurance techniques need to be applied to these systems to guarantee data quality for these embedded systems. Rapid access to large volumes of data can be facilitated by following industry standard approaches used in data warehousing and even the human genome project, where very large volumes of data need to be efficiently searched to extract information.

PHASE I: Describe the requisite processes, and design a solution to support long term data management and retrieval within the context of this application. Develop a detailed approach to assess and ensure data integrity, and to support rapid access to information within very large databases. A process or software solution utilizing current systems would be preferred over adding new hardware.

PHASE II: Develop a prototype data management system which encompasses the designs from Phase I and demonstrate the utility of these techniques and processes to a naval combat system application.

PHASE III: Apply the techniques and processes in Phase II into a naval combat system data collection system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Data storage warehouses and enterprise data storage users. Many corporations suffer critical data loss due to their inability to make adequate archives or to efficiently access the information they contain.

REFERENCES:

1. "Preserving Digital Information," Report of the Task Force on Archiving of Digital Information, commissioned by the Commission on Preservation and Access and The Research Libraries Group, Version 1.0, August 24, 1995.
2. "Digital Imaging and Optical Digital Disk Storage Systems: Long-Term Access Strategies for Federal Agencies". Technical Information Paper No. 12. National Technical Information Service, Washington, D.C. (1994).
3. "Data Mining Solutions: Methods and Tools for Solving Real-World Problems" by Christopher Westphal & Teresa Blaxton (1998)
4. "Data Preparation for Data Mining", by Dorian Pyle (1999)

KEYWORDS: storage; archiving; mining; database; integrity; retrieval

N04-037 TITLE: New Approaches for Reducing Helmholtz Resonance in Submarine Structures.

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: N77 ACAT 1.

OBJECTIVE: Develop and Demonstrate Technologies to Eliminate/Minimize Helmholtz resonance for submerged vehicles moving through fluids.

DESCRIPTION: Submarines moving through the sea often experience the undesirable effects of helmholtz resonance as seawater flows past openings in the hull. The significance of these resonances can vary from acoustic annoyance, to performance degrading, to structurally damaging. Predicting these resonances during design is difficult due to the number of openings, the differences in the size and shape of those openings, and the differences in the size, shape and amount of equipment in connected tanks. Further complications occur when a resonance from one opening begins to interact with resonances generated at other openings. The problems created by these resonances aren't usually discovered until sea trials, late in the construction process, leaving little time to conduct detailed analysis, let alone devise appropriate solutions. Therefore, devising solutions that eliminate or reduce the magnitude of these resonances becomes an effort of trial and error. The end result is often a temporary solution that is largely unsuitable for use on an operational submarine. Often, the solution can cause additional problems for the submarine that can be just as negative as the original problem.

Tools are needed that will provide the designer and engineer with the ability to predict the occurrence of these resonances during design. These tools need to allow for the evaluation of alternative designs that would avoid the resonances, or solutions that will eliminate or minimize any potentially damaging or performance degrading resonances. In addition, since it is expected that eliminating all resonances will not be possible through good design, new ways of eliminating, or minimizing resonances that are discovered late in the construction process are also desired. These types of solutions must be minimally invasive (i.e., not require wholesale redesign of the submarine hull, tanks or tank structure), have a high likelihood of achieving the desired result, and must be something that can be quickly applied and evaluated.

PHASE I: Develop and demonstrate analysis tools/methodologies to clearly assess the potential for the development of complex Helmholtz resonance in a submarine design and that would be useful in developing solutions.

PHASE II: Use tools and methodologies developed in Phase I to design treatment alternatives to minimize or eliminate typical submarine Helmholtz resonance.

PHASE III: In Phase III the fruits of this effort will be used to solve problems related to Helmholtz resonance in an operational submarine. The tools developed under this effort will be used to first predict helmholtz resonance, define the magnitude of the problems occurring as a result of this resonance and then devise one or more solutions that will to eliminate or minimize the resonance.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technologies developed here would also have application to the design and construction of commercial ships and aircraft (as well as there military counterparts). There would also be application to the design and construction of tall buildings or other structures that are placed in environments where high wind speeds occur frequently enough that such resonances might degrade their performance or cause damage.

KEYWORDS: helmholtz, resonance, vibration, noise, acoustics, structural fatigue

N04-038 TITLE: Broad Band Acoustic Modeling of Reverberation for Torpedo Simulators

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT III: PMS415 and PMS404

OBJECTIVE: Develop Broad Band Acoustic Modeling Concepts and Algorithms to simulate broadband reverberation in support of the evaluations of Undersea Vehicles in Torpedo Simulators.

DESCRIPTION: The high cost of in-water torpedo testing and evaluation and the diversity of acoustic environments brought forth by the need to operate in shallow waters have required the use of high fidelity torpedo simulators. Additionally current funding available only provides for a very limited and focused scope of in-water testing. A critical component in the above mention torpedo simulation is the modeling of the time signature of the reverberation caused by the active acoustic interrogation by a torpedo. Current simulations require a range dependent (bathymetry dependency) acoustic propagation modeling capability with sufficient computational efficiency to support predictions in real time of the reverberation time signature in M by 2D planes. Clearly a true 3D reverberation model would be ideal but probably its computational requirements would limit its usefulness in a real time simulation environment. The development of a computationally effective range dependent reverberation model would provide the Navy with an enhance capability in torpedo simulators that will minimize full scale testing while providing a high level assessment of their performance. Torpedo simulators currently in use include hardware in the loop and digital simulations.

PHASE I: Develop, analyze and trade off Candidate Concepts for modeling broad band acoustic reverberation for the evaluation of undersea weapons in a Torpedo environment. Develop high level requirements report documenting concepts and their evaluations. Additionally the report should address simulation architecture issues.

PHASE II: Develop one or two of the most promising concepts and evaluate the run times and resulting fidelity of the predictions. During this effort the contractor in cooperation with the Navy would also address simulation architecture issues that could enhance fidelity and/or mitigate some run time issues.

PHASE III: During this final stage the Naval Undersea Warfare Center (Newport) and Applied Research Laboratory, Penn State University, with the backing of PMS404 and PMS415, will integrate the new M&S capability into the WAF (hardware in the loop simulator) and TRM (digital simulator) to support weapons and CM evaluations. Additionally the modeling concept will be made available to any other organization in the Naval community. The NUWC will maintain and support the model through out its life cycle.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Many companies that support the Navy are investing heavily in the area of Modeling and Simulation. Development of this model will provide the contractor with a unique capability to support torpedo and countermeasure developments.

REFERENCES:
1. Developer's Response to " Quick-Look at Grab in Shallow Water at Tactical Frequencies" NUWC-NPT Technical Memorandum 990038. Authors: H. Weinberg, R. Keenan and F. Aidala. April 15, 1999
2. Modeling Cape Cod Site C and Site D Torpedo Reverberation Data with the Comprehensive Acoustic System Simulation. NUWC-NPT Technical Memorandum 10,590. Authors: H. Weinberg, R. Keenan and F. Aidala. July 11, 1996
3. Torpedo Reverberation Data Modeling with the Comprehensive Acoustic System Simulation (CASS). NUWC-NPT Technical Memorandum 10,480. R. Keenan, H. Weinberg. June 6, 1995.

KEYWORDS: Reverberation; Acoustics; Propagation; Range/Dependent; CASS/GRAB; Torpedoes.

N04-039 TITLE: Parametric Sonar to Enhance Torpedo Performance

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: ACAT III; PMS404

OBJECTIVE: Improve active torpedo homing in shallow water by using parametric sonar in conjunction with conventional linear sonar.

DESCRIPTION: Non-linear parametric sonar provides the capability to generate relatively lower frequency acoustic signals with narrower beamwidths and nearly non-existent side lobes in contrast to its conventional linear sonar counterpart. These attributes of higher spatial resolution and side lobe elimination can potentially be used to achieve significant reductions in volume and surface scattering strengths in the reverberation-limited littorals and to realize significant reductions in false-alarm rate. Moreover, parametric sonar has the potential to discriminate small and large underwater objects in a frequency band not readily subject to acoustic countermeasures, thereby offering the added capability of a marked reduction in threat countermeasure effectiveness.

The key elements of establishing the feasibility and practicality of parametric sonar for torpedoes include (a) the feasibility and verification of high frequency parametric transduction and, via the medium, a lower (difference) frequency realization; (b) parametric sonar effectiveness against countermeasures; and (c) full-scale testing and verification of development features. Using existing torpedo transduction design, the capabilities of a parametric sonar need to be demonstrated in a realistic operational setting. Namely, two primary frequency sources emanating from the same array must be simultaneously transmitted into the medium [reference (1)]. The parametric difference frequency may be realized across a number of frequency bands, depending on the selected primary transmitted waveforms. A major part of this effort will entail optimizing the parametric receive band for reducing countermeasure effectiveness. Finally, full-scale tests will need to be conducted before transitioning this technology to the fleet.

PHASE I: Develop and demonstrate proof-of-concept for high frequency active parametric sonar applicable to tactical scale underwater vehicles (UUVs/weapons). Specifically, develop and demonstrate proof-of-concept for detection, classification, and decision-making with parametric sonar that enables the discrimination of small and large underwater objects in frequency bands not subject to countermeasure jamming. Verify concepts by analyses. The proof of concept should answer the following questions. What are the spectra of options for primary and secondary (difference) frequency selection based on existing torpedo transduction design? What are the design tradeoffs relating power efficiency, primary and difference frequency selections for minimizing threat countermeasure effectiveness and for maximizing torpedo homing performance? What are the (measured) realizable beamwidths of the parametric sonar beam? What are the (modeled) expected homing range performances of the parametric sonar, in the respective typical operating areas of interest? What are estimates of the typical volume and surface backscattering dependency as a function of frequency for these operational environments?

PHASE II: Prototype the high frequency transducer/array concept for parametric sonar and demonstrate capability of application to UUV/weapon application by static acoustic laboratory testing. Validate capability to avoid and penetrate countermeasure field during testing.

PHASE III: Provide full-scale operational torpedo prototype
and perform operational testing. Demonstrate the capability of parametric sonar to discriminate between target and countermeasure in a highly reverberant environment.

PRIVATE SECTOR COMMERCIAL (Dual-Use) POTENTIAL: Parametric sonar transmissions can produce low frequency narrow acoustic beams. Private sector applications include, as examples the medical field (ultrasonic imaging), marine industry (sea floor and sub-bottom profiling, acoustic communications [reference (2)] as well as other fields where non-obtrusive insonification may be desired [reference (3)].

REFERENCES:

1. R.T. Beyer, Nonlinear Acoustics, Van Nostrand Reinhold Company, 1984
2. A.H. Quazi and W.L. Conrad, Underwater Acoustic Communications, IEEE Communications Magazine (March 1982)
3. W. Von Winkle, Editor, Scientific and Engineering Studies: Nonlinear Acoustics 1953-1984, Naval Underwater Systems Center
4. J. Wunderlich and S. Müller, High-resolution sub-bottom profiling using parametric acoustics. International Ocean Systems, July/August 2003, pp. 6-11.

KEYWORDS: sonar; parametric; torpedo; homing; littoral; countermeasure

N04-040 TITLE: Electric Direct-Drive Actuator for the Universal Modular Mast

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Materials/Processes, Electronics

OBJECTIVE: Provide an electric, direct-drive linear motor and power-electronic system for actuation of the Universal Modular Mast (UMM).

DESCRIPTION: For the next generation of submarine masts, an all-electric actuator is needed to replace the present hydraulic cylinder supporting the operation of the UMM. Given the requirements for long life, high-reliability and very low noise, a true direct-drive solution is sought. Replacement of maintenance-intensive hydraulic actuators outside the pressure hull with electric actuators will increase reliability, reduce weight, improve safety, reduce manning, decrease maintenance, and reduce total operating costs for submarines and other applicable platforms. Electric actuators will require less time for Sailors to perform maintenance thus allowing more time for his/her Quality Of Life (QOL) activities. Also, electric actuators will provide a cleaner environment, eliminating the potential safety hazards resulting from leaking hydraulic actuators and associated piping systems. For safe and reliable operation of the UMM, the actuator must not use any high-pressure (>20 psi) seals, have any type of mechanical transmission, nor require repetitive braking or clutching. Approximate performance specifications are as follows: 12 ft overall length, 10 ft stroke, +/-10,000 lb thrust, +/-1 ft/sec max speed, 6 inch diameter cross-section, and <5 kW of static power dissipation at full-thrust. The actuation system will require a fail-safe brake and a power-electronic system that minimizes all sources of mechanical vibration. Minimization or elimination of sensors is desirable. Depending on the maturity of the linear motor technology, this program may focus on advanced control methods, manufacturing techniques, subsystems (e.g. brake and pressure compensation), and in-depth testing.

PHASE I: Develop preliminary designs for the motor, brake, sensors, and/or power-electronics/controls. Show feasibility through analysis and/or proof-of-principle experiments.

PHASE II: Develop a prototype that will demonstrate the efficacy of the motor, brake, and/or power electronic system using a full-force, reduced-stroke motor. Conduct testing to evaluate critical parameters (e.g. thrust, speed, power dissipation, noise, life, etc.).

PHASE III: Build a full-scale production-prototype UMM actuator and work with the UMM manufacturer to conduct final testing. Design and build production tooling and oversee production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The desired actuator technology provides force-density similar to hydraulics without the need for gears or screws. Expected advantages are zero maintenance, low noise, zero backlash, low or zero friction, back-drivability, high positioning accuracy and high control bandwidth. The technology could ultimately replace hydraulic cylinders in all types of heavy equipment (e.g. materials handling, earth moving, agricultural machinery, etc.). Initially, the actuator will be useful in high-performance applications such as control-surface actuators for ships and aircraft, industrial robotics, machining centers, and human-amplification devices.

KEYWORDS: actuator, linear motor, direct-drive, electric, high-force, electro-mechanical

N04-041 TITLE: Advanced Shipboard Electrical Control and Monitoring

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT ID; PMS 378; PEO Carriers

OBJECTIVE: Develop an electrical monitoring and control system that reduces total shipboard electrical current used and maximizes the electrical efficiency of the existing power supply.

DESCRIPTION: USS John F Kennedy (CV 67) is the first modern aircraft carrier to have its electrical demand outstrip the electrical power available. The Navy is considering the installation of an additional SSTG to handle future power generation needs of this ship.

An alternative to providing additional power generation capacity is developing a system that maintains total shipboard electrical current used at the most economical load and maximizes the electrical efficiency of the existing power supply.

The integrated “Smart Load Center” system developed through this SBIR effort could utilize new innovative devices to achieve the stated objective or leverage existing technologies such as; capacitive systems, reduced current starting devices, high efficiency motors and/or smart motor controllers to reduce the total current used.

In concert with these approaches to reduce electrical demand, the Advanced Shipboard Electrical Monitoring and Control System (EMCS) will be able to continuously monitor the demand side of the electrical load and be programmed to recognize and respond to shortfalls of electrical generation. One response could be selective load shedding when demand begins to exceed the supply of power.

Such energy conservation techniques have been unnecessary in the past due to readily available and inexpensive fuel and the negligible increases seen in electrical loads over the course of a ships life. With the high cost of fuel today and the expectation that those increasing trends for energy costs will continue indefinitely. The benefits of monitoring and controlling the demand side of the power grid will have an increasing return on investment.

PHASE I: Identify cost effective techniques and approaches that may be used to maximize the existing power supply, continuously monitor the demand side of the electrical load, and be programmed to recognize and respond to shortfalls of electrical generation. Identify various software and hardware monitoring and control system architectures and make recommendations as to which ones have the greatest potential for long term savings to the Navy in manpower, procedures, and fuel. Also show the benefits in; weight reduction vs. new SSTG, environmental concerns, maintenance, implementation, and lifecycle cost issues.

PHASE II: Develop a cost effective prototype system that demonstrates effective electrical system demand reduction and electrical supply monitoring and control for brassboard validation in a relevant environment. Provide a cost estimate for the systematic qualification and installation of a system that will include the most beneficial aspects of Phases I and II.

PHASE III: Demonstrate the performance of the new high efficiency electrical system and system monitoring and control capabilities, through the installation of elements in a networked manner on board ship. Include monitoring capabilities to compare the changes in electrical demand with and without the new devices and techniques. Demonstrate the improvements in response time and availability by monitoring demand and control features.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Power generation plants and large manufacturing plants that utilize their own power generation are the most probable candidates for using the techniques identified over the course of this study. Commercial shipping also has such potential for reducing total ownership costs.

REFERENCES:
1. OPNAVINST 5090.1b
2. MIL-STD-1399
3. MIL-E-917E(NAVY)
4. MIL-M-24116B(SH)
5. MIL-M-24350B(SH)

KEYWORDS: Smart load center, Electrical demand control, Smart motor controller, Soft start, Monitor, Variable speed motor controllers, Power factor correction, Energy efficiency, Environmentally friendly, High efficiency motors.

N04-042 TITLE: Lightweight Shipboard Inclined Ladder

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT ID; PMS 378; PEO Carriers

OBJECTIVE: Identify alternate material/s for the fabrication of inclined ladders. Materials are to be lighter in-weight than aluminum, offer higher resistance to shipboard fire temperatures and meet or exceed current aluminum ladder design strength requirements. Fabrication cost for the new Inclined Ladders are to be relatively in-line with current aluminum inclined ladder purchase cost.

DESCRIPTION: Structural steel has a long history of providing superior mechanical properties in shipbuilding, but with one major disadvantage: weight. Ship designers have searched for alternative materials that will reduce the weight of the ship without compromising strength or performance. Aluminum inclined ladders have fulfilled this need, inclined ladders to allow passage from one deck to another deck, and there are hundreds of ladders installed on the ship. Typically aluminum inclined ladders are installed throughout US NAVY ships with the exception of machinery spaces and are approximately 1/3 lighter in weight then steel inclined ladders. Steel inclined ladders are the ladders of choice onboard US Navy ships, since they offers superior resistance to fire, however, using aluminum inclined ladders reduces overall gross weight which allows for the installation of additional warfighting capability or equipment. In general aluminum has a lower melting point than carbon steel, yet shipboard fires often exceed the melting point of aluminum by several hundred degrees. Aluminum inclined ladders exposed to shipboard fires are suspect for use by the firefighting teams, and may limit available escape routes.

PHASE I: Identify and define suitable materials for shipboard inclined ladders. Review Standard US Navy Aluminum Ladder engineering and fabrication details, compare selected materials to existing design, and perform engineering analysis of new ladder materials; includes finite element modeling, and load analysis.

PHASE II: Fabricate prototype inclined ladder/s. Subject ladder/s to first article testing; includes mechanical testing, weight testing, fire, smoke and toxicity testing, if applicable water absorption test, vibration testing and environmental chamber testing. Some testing will require the inclined ladder assembly to be attached to structure to simulate actual shipboard conditions.

Install three (3) prototype ladders onboard an active ship as technology demonstrators. One ladder shall be placed in high traffic, weather deck location, the other ladder at an internal high traffic location and install the third ladder at a remote location. Ladders will remain onboard the ship for a period of at least one year. After that time ladders will be removed from the ship and disassembled. Each ladder will be subject to selective testing such as fatigue testing, NDT testing or mechanical testing. Tests will be conducted to measure the amount of degradation and to ensure new materials meet or exceed existing aluminum ladder performance. Finalize prototype lightweight inclined ladder drawings; make drawings applicable for commercial fabrication.

PHASE III: Backfit lightweight inclined ladders on existing US Navy ships and install on all future US Navy ships.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology developed through this project can be applied to commercial shipbuilding applications; cruise ships, cargo/container ships, the oil platform construction as well as commercial/industrial building construction.

REFERENCES:
1. MIL-STD-167, MIL-STD-271, MIL-STD-889
2. MIL-S-901D
3. UL-1709
4. ISO/TR 3956:1975
5. ASTM F 1473, ASTM F 1092
6. ASTM P 191
7. MIL-T-24634
8. NFPA 1931
9. ASTM-E-119
10. ASTM-B-117
11. Safety of Life at Sea (SOLAS)

KEYWORDS: ladders; inclined ladders; steps; stairways; stair-ladders; outfitting, aluminum

N04-043 TITLE: High Charge per Bunch Photocathode

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Design, develop and demonstrate high charge per bunch photocathodes for Free Electron Laser (FEL) shipboard self-defense applications.

DESCRIPTION: The Directed Energy Program Office is soliciting Small Business Innovative Research Proposals for the development of high-quantum efficiency, photocathodes to support the development of high-power Free Electron Lasers (FELs). The current produced by a given photocathode is determined by the given drive laser and photoemissive material used in its construction.

$$i(mA) = \frac{\lambda(nm)}{124} \bullet P_{laser}(W) \bullet Q.E.(\%)$$

The photocathodes of interest for this solicitation have the following parameter ranges: a bunch charge of 0.5 to 3.0 nC with bunch lengths of 0.5 to 10 picoseconds. The photocathodes must be capable of operating continuously with a repetition rate of no less than 750 million pulses per second [average currents in the range of 0.35 to 1.5 A]. The photocathode design must be consistent with an injector normalized output emittance of no more than 10 mm-mrad. Photocathode lifetimes must be greater than 1000 hours under continuous operation, and designs that allow insitu replenishment will be given preference. The design of the photocathode surface shall be such as to support an average injector acceleration gradient in excess of 7 MV/m.

PHASE I: Investigate and develop the design of a photocathode capable of meeting the design goals as described in the Description section above. The Phase I report should provide a rationale for the choice of the design including cathode shape and support structure, photo emissive materials used, methods of treating and maintaining cathode surfaces in acceptable emission condition, perform electric field stress calculations over the face of the cathode and estimate the average injector gradient, and specify the drive laser requirements.

PHASE II: Utilize the results of the Phase I design to devise and construct a scaled physics demonstration of the required performance.

PHASE III: Integrate the design into the Navy's FEL Engineering Design Model (EDM) for concept of operation testing.

PRIVATE SECTOR COMMERICAL POTENTIAL: Free Electron Lasers are being considered for a number of commercial applications. Although the power levels for these applications are within the current state, the development of more reliable and lower maintenance photocathodes will increase there commercial viability.

REFERENCES:
1. DoD Master Plan Volume II, August 2, 2001. ODUSD (S&T()/WS LMP Vol-II, 22 September 2001.

KEYWORDS: FEL, Free Electron Laser, photocathode, current injector

N04-044 TITLE: Airdroppable High Speed, Low Signature Craft

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Sensors

OBJECTIVE: Develop and demonstrate a high speed, low signature airdroppable craft to facilitate and enable the capability for long distance, rapid insertion of low cost mobile surveillance mission sensor package.

DESCRIPTION: Current airdroppable sensor packages are stationary. Unmanned vehicles need surface ship or submarine support craft which incur delays in relocation to deployment areas and add risk to delivery support ships. There is a need for a rapidly deployable and affordable craft that can survive the stresses of air delivery and be controlled to move under its own power to multiple locations to respond to changing tactical requirements. Optimal production quantity cost would be in the range of $100,000 to $ 500,000 with the goal of reducing the cost to an acceptable level to allow attrition and eventually expendability.

Radar and visual signatures should be reduced to the lowest capable yet affordable level to reduce detection and attrition.

PHASE I: Characterize high speed advanced hull forms with low-signature, low-cost characteristics for airdroppable delivery applications. Conduct analysis to assess performance, costs and signature reduction. Investigate airdroppable delivery techniques suited to US inventory aircraft, and evaluate craft capacities. Craft design should include propulsion system but not the remote or autonomous control system. Examine operational scenarios and envelope based on design characteristics, including payload, range, speed, drop limits, and other parameters.

PHASE II: Select no more than two candidate hull forms from Phase I. Develop an prototype to be demonstrated at full or reduced scale in an actual or physically simulated airdrop. Demonstrate craft mobility and seakeeping in an actual or physically simulated seaway. Use of interim or simulated control packages are anticipated. Evaluate the capability to accommodate various potential sensor packages such as electro-optical, infrared, and radar.

PHASE III: Develop a prototype deployable system matched to available sensors and control systems. Develop an implementation plan for operational test and evaluation.

REFERENCES:
1. "Unmanned Aerial Vehicles Roadmap 2000-2025", Office of the Secretary of Defense, United States of America, April 2001.

2. "Potential Unmanned Vehicles and Design Impacts on the LHA(R), Grant Rosssignol and Steven Wells, NSWCCD-20-TR-2003/08, April 2003.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is potential for use as a rapid reaction security surveillance system for Homeland Security, Coast Guard, Offshore oil platforms. Alternate usage would be as a deep ocean lifeboat.

KEYWORDS: Airdroppable; low cost; low signature; small boat; mobile surveillance.

N04-045 TITLE: Bore Insulator Materials for a Naval Electromagnetic Launcher

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Directed Energy and Electromagnetic Weapons PMS 405

OBJECTIVE: Develop toughened electrically insulative bore materials of significant lengths used to separate copper conducting rails in an electromagnetic launcher (electric railgun).

DESCRIPTION: The US Navy is pursuing the development of an electromagnetic launcher (also known as a railgun) for long range naval surface fire support. An electromagnetic launcher consists of two parallel electrical conductors called rails, and a moving element, called the armature. Current is introduced at the end of one rail, flows down the rail, though the armature and returns via the second rail. The armature, which sits behind the projectile, is accelerated down the launcher bore due to the interaction between this magnetic field and current flow.

The rails of an electromagnetic launcher are supported a certain distance apart from each other by a pair of perpendicular electrically insulative bore pieces. Therefore, the armature slides through the launcher between to two parallel conducting rails and two parallel insulator components perpendicular to the rails. A notional insulative bore material section might have, but is not limited to, dimensions such as .3m x .04m x 10m. Insulator materials need to be capable of withstanding the severe mechanical, electrical, and thermal environment present in the bore of a high power electromagnetic launcher. This component needs to be adequately tough, have a high compressive strength, and minimize thermal expansion due to fluctuations in rail temperature between 300 – 400 degrees Kelvin. . The insulator surface must be able to withstand sliding contact aluminum and nylon at velocities up to 2.5 km/sec. Potential materials may include, but is not limited to, a toughened ceramic or a fiber reinforced composite with a high melt temperature matrix material.

PHASE I: Develop a process approach to manufacturing toughened electrically insulative bore materials of significant lengths (7 – 12 meters). Conduct any necessary subscale tests needed to show that the proposed process is suitable for Phase II demonstration.

PHASE II: Produce sample electrically insulative bore materials of significant length that meet the needs of the EM launcher environment. Demonstrate that the material system provides adequate material property characteristics. Further develop and demonstrate the process for fabricating long pieces. Produce a prototype set of bore insulator sections as specified in GFI to be delivered to the Navy for testing in a large scale EM Launcher.

PHASE III: The materials process developed by the Phase II effort will be applied to navy EML proof of concept demonstration and design efforts and, ultimately, in a system on board ship.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The materials and processes developed could be applied to any electro-mechanical applications particularly under conditions of high heat and high stress requiring both the beneficial thermal and high compression strength aspects of materials such as ceramics combined with the need for higher toughness and relatively long sections. Example applications could be high-speed mag-lev applications, possibly very large bore MRI applications, and sections for re-entry protection of space-craft.

REFERENCES:
1. Stevenson, R.D.; Rosenwasser, S.N.; Washburn, R.M., “Development of Advanced Ceramic Matrix Composite Insulators for Electromagnetic Railguns”, Magnetics, IEEE Transactions on , Volume: 27 Issue: 1 , January 1991, Page(s): 538 -543.
2. Noel, A.P.; Bauer, D.P., “Laminated Barrel Axial Stiffness Assessment [of railguns] “, Magnetics, IEEE Transactions on , Volume: 37 Issue: 1 , Jan 2001, Page(s): 454 -456.
3. Bauer, D.P.; Newman, D.C., “High Performance Railgun Barrels for Laboratory Use”, Magnetics, IEEE Transactions on , Volume: 29 Issue: 1 , 28-30 Apr 1992, Page(s): 362 -367.

4. Newman, D.C.; Bauer, D.P.; Wahrer, D.; Knoth, E., "A Maintainable Large Bore, High Performance Railgun Barrel", Magnetics, IEEE Transactions on , Volume: 31 Issue: 1 , January 1995, Page(s): 344 -347.
5. Hurn, T.W.; D'Aoust, J.; Sevier, L.; Johnson, R.; Wesley, J., "Development of an Advanced Electromagnetic Gun Barrel", Magnetics, IEEE Transactions on , Volume: 29 Issue: 1 , Jan. 1993, Page(s): 837 - 842.

KEYWORDS: Electromagnetic launcher, railgun, toughened ceramics, weapon system, Naval Surface Fire Support

N04-046 ~~TITLE: MW Class Near Infrared Optics~~

Topic N04-046 has been cancelled. See topic N04-101

N04-047 TITLE: Fiber optic power meter with optical detector in a detachable probe.

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: To develop a fiber optic power meter that has an optical detector in a small probe that is separate from the enclosure that houses the controls, display device, and other components of the power meter.

DESCRIPTION: Currently fiber optic power meters have the optical detectors, display device and other control circuitry enclosed in a single housing. These units can be used to measure the power out of typical single fiber cable connections, but must utilize special jumper cables to measure power at patch panel adapters/coupling or out of multi-fiber connections.

The use of special jumper cables to take measurements can present problems. Unique cables are required for each unique connector configuration to be tested. This uniqueness can make these jumper cables expensive. In addition, jumper cables require certification, careful handling, and periodic routine maintenance. Because the jumper cable is placed between the link and the optical detector, additional loss is introduced into the measurement. It would be desirable to have a power meter that will allow one to take a measurement on any fiber link without using a jumper cable. Currently there are video inspection systems that use a probe technology in a portable hand held system (see http://www.westoverfiber.com/insprobeset.html and http://www.alcoa.com/afl_tele/en/product_category.asp?cat_id=71). Although these references are for video inspection systems, they demonstrate that the technology is feasible.

PHASE I: Establish performance specifications for the fiber optic power meter base unit and the power meter probe. Develop and document a recommended conceptual power meter design. If possible, develop a breadboard unit to demonstrate proof of concept.

PHASE II: Perform trade studies on the probe design. Complete the base unit and probe design. Build a prototype unit using the recommended design. Validate the optical and thermal performance of the prototype. Demonstrate the use of the prototype with typical Navy fiber optic connector products.

PHASE III: Transition the prototype from Phase II into production for use by Navy technicians and commercial users.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial or private sector technicians who are required to maintain a fiber optic network system will use this product. This product has the potential to almost completely replace traditional power meter products.

REFERENCES:
1. http://www.westoverfiber.com/insprobeset.html
2. http://www.noyes-fiber.com/products/products.htm#pr10

KEYWORDS: Power meter; probe optical detector; power meter manufacturing; optical detector; optical detector manufacturing; probe

N04-048 TITLE: Low Magnetic Signature, Rechargeable, Modular Battery Technologies for Mine Warfare

TECHNOLOGY AREAS: Electronics, Weapons

ACQUISITION PROGRAM: IV and Abbreviated Acquisition Programs

OBJECTIVE: Develop non-magnetic, modular, rechargeable power source for use in moderate-rate mine warfare systems.

DESCRIPTION: Non-magnetic electric power sources are an enabling technology for mine warfare systems because most of the supporting systems use electronics to enhance organic capability or to power vehicles, and mine countermeasure (MCM) requirements dictate the use of low magnetic signature components. Rechargeable power sources offer the attraction of significant decreases in life cycle costs when they can be used in place of primary (non-rechargeable) batteries. The development of a non-magnetic rechargeable power source could provide the Navy with a “building block cell” to use in the design and manufacture of rechargeable batteries for new and existing mine warfare systems.

PHASE I: Research, develop and document cell and battery design approaches that could be used to produce low magnetic signature, rechargeable, modular batteries. Focus on proof-of-concept technology development. White paper deliverable shall include descriptions of proposed cell and batteries designs, as well as a trade off analysis of the proposed approaches.

PHASE II: Design and manufacture prototype cell samples to submit to the Navy for independent magnetic signature analysis and performance evaluations. Also, design and manufacture a prototype rechargeable battery that is projected to have the performance characteristics listed in Table 1. Conduct magnetic signature and performance characterization testing to evaluate battery prototype performance against the specified requirements. Deliver prototype battery samples to the Navy for independent magnetic signature analysis and performance testing.

	Threshold	Objective
Magnetic Signature	5 gamma at 12 inches (when tested in accordance with MIL-DTL-19595D with battery under load)	<5 gamma at 12 inches
Voltage	18 volts maximum / 10.5 volts minimum	18 volts maximum / 12.1 volts minimum
Discharge profile	16 watts	21 watts
Capacity	160 Watt-hours	260 Watt-hours
Cycle life	300 cycles	1000 cycles
Recharge time	8 hours	4 hours
Weight	5 pounds in air / neutral in water	5 pounds in air / neutral in water
Dimensions	9.5 inches long x 4.5 inches wide x 3.25 inches deep	9.5 inches long x 4.5 inches wide x 3.25 inches deep
Operating/Storage Temperature	0°F/-65°F minimum & 100°F/160°F maximum	0°F/-65°F minimum & 100°F/160°F maximum
Depth Rating	300 feet / 136 psi	2000 feet / 900 psi

Table 1. Electrical Requirements for Rechargeable Power Source

PHASE III: Refine the battery design developed in Phase II as needed to meet all the threshold performance requirements of Table 1. Transition the battery design from prototype to commercial production, including completing required testing to meet Department of Transportation (DoT) regulations given in the Code of Federal Regulations. Deliver production representative battery samples to the Navy for safety testing in accordance with NAVSEA INST9310.1b and NAVSEA TM S9310-AQ-SAF-010 (if required). Explore additional battery configurations to meet power requirements for other mine warfare systems, such as training/laying mines.

OTHER NAVY TRANSITION POTENTIAL: Although the specific power source requirements given in Table 1 target the Underwater Imaging System (UIS), within the Mine Warfare community a variety of power sources could benefit from the Phase I design and development effort proposed in this topic. Specifically, PMS Naval Special Warfare (NSW) would be able to transition the Phase I effort into a battery design for the Hydrographic Reconnaissance Littoral Mapping Device (HRLMD) provided that the objective level for discharge profile could be met. Also, PMS 490 could derive a significant cost benefit from a baseline cell design for rechargeable batteries for training and exercise mines in place of primary batteries.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Although non-magnetic power sources are of limited interest in the commercial sector, medical tools used in magnetic imaging suites and certain ground embedded, automotive sensing devices routinely use small, high-energy, non-magnetic lithium batteries. A non-magnetic rechargeable battery could benefit this market by decreasing total life cycle costs for these systems.

REFERENCES:

1. NAVSEA INST 9310.1b of 13 June 1991
2. NAVSEA TM S9310-AQ-SAF-010 of 20 July 1988
3. Code of Federal Regulations (CFR) 49 CFR 173.185 (http://www.access.gpo.gov/nara/cfr/)

KEYWORDS: batteries; magnetic signature; lithium batteries; rechargeable; mine warfare; mine countermeasures

N04-049 TITLE: Air-cooled High-power Blue-Green Laser

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: PEO for Littoral and Mine Warfare (PEO(LMW)), PMS-210

OBJECTIVE: Develop a high-power (>4 Watt) solid-state pulsed laser which can be operated over an ambient temperature range from 0° - 120° F without requiring an extensive environmental conditioning unit for maintaining temperature control.

DESCRIPTION: The United States Navy is developing airborne mine detection systems which use laser illumination coupled with sensitive electro-optic receivers to find mines in the upper part of the water column. The equipment currently under development (AN/AES-1) is intended for operation from a manned helicopter. The next generation of such equipment is expected to operate from unmanned aerial vehicles (UAVs). Such platforms are anticipated to provide less payload and power than is available from the current helicopter. The single biggest subsystem in terms of weight and power consumption in the current system is the laser and its associated environmental conditioning equipment (ECS). It is therefore desired to begin to develop the technology required to reduce the weight and power consumption of the laser to permit transitioning this mine countermeasures capability to UAV platforms. Specific weight and power consumption goals will be established at contract award, but will be approximately 100 pounds in weight, and have an overall power consumption of less than 4500 Watts. The system will be employed in a relatively high vibration environment. Therefore, vibration-sensitive designs should be avoided from the outset, although the design will not have vibration specifications imposed earlier than Phase III. Further, the pulse repetition frequency of the laser must remain stable.

PHASE I: Develop a design for a laser system (including the laser transmitter, any required control electronics, power supply (or supplies), and environmental control means) to meet the desired goals. The specific laser technology to be employed is at the discretion of the contractor, so long as the laser output lies in the wavelength range between 500-540 nm. The current system uses frequency-doubled Nd:YAG at 532nm.

PHASE II: Build and demonstrate a prototype laser built according to the design criteria established in Phase I. The laser shall meet all safety criteria established in ANSI Z136.1-2000 for military exempt lasers. The demonstration shall be carried out in a laboratory (i.e., benign) environment, but shall be so structured as to demonstrate functionality over the intended temperature range. For demonstration purposes, an induced airflow simulating in-flight operation is permissible. An additional output of this Phase is to be a report showing how the developed technology can be scaled to higher power (in the 40-50 Watt range), and (if necessary) to a pulse repetition rate suitable for meeting AN/AES-1 technology insertion requirements (currently on the order of 100hz).

PHASE III: Assuming a successful Phase II, the developed laser would be transitioned to a Phase III effort to include the laser as a P3I replacement for the current laser in the AN/AES-1, and/or the follow-on program for operating an AN/AES-1 capability from a UAV.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Lasers currently find wide applications in such diverse fields as medicine and entertainment; the laser proposed for development under this topic might well find application in any of the fields currently employing lasers operating in the blue-green portion of the spectrum. The reduction in weight and power consumption, coupled with a high average power, would most naturally be expected for employment in laser surgery, in environmental exploration, in underwater imaging, and similar activities.

REFERENCES:
1. American National Standards Institute ANSI Z-136.1-2000, "American National Standard for Safe Use of Lasers"

KEYWORDS: laser; pulsed-laser; underwater sensors; reconnaissance; minehunting; airborne

N04-050 TITLE: Advanced Submarine Compatible Electric Power Source for Miniaturized Mine-Neutralization Vehicle Power

TECHNOLOGY AREAS: Materials/Processes, Electronics

OBJECTIVE: Develop high energy power systems capable of providing electric power to a miniature high performance unmanned underwater vehicle (UUV) and a remotely operated vehicle (ROV) for airborne and submarine deployed mine-neutralization.

DESCRIPTION: The development of an energy dense, power dense, underwater compatible power system will extend the capabilities of semi-autonomous (ROV) or fully autonomous (UUV) mine-neutralization systems. The typical power sources considered for one-shot, zero-maintenance embedded electrical supplies are electrochemical batteries. Combination of environmental requirements for storage and operation, high specific energy and long-endurance dictate the use of lithium chemistries. Lithium batteries capable of high-energy and long-term storage with high-power capabilities pose potential hazards to airborne and submarine deployment platforms from variety of causes including potential exposure of crew to noxious or flammable gases, potential hazards to co-located munitions internal to the device or external in storage magazines. An ideal system would provide in a mass and volume constraint of 1.4 kg and 1400 cc, 7 to 13 VDC at power levels of 100 to 120 watts for durations of 1 to 3 hours. The power source should be capable of surviving five (5) years of uncontrolled storage (-54C to 75C) followed by immediate deployment. Deployment temperature is 0°C to 55°C with operation in ambient water environments. Ideally the power source should be self-contained, mechanically and electrically quiet, tolerant of deep-water pressure conditions, require no maintenance prior to operational deployment and not generate or release excess heat to nearby electronics and munitions. The power source shall, as a minimum, be subjected to the environmental and electrical conditions based upon NAVSEA Technical Manual S9310-AQ-SAF-010 and MIL-STD-2105.

PHASE I: Design, develop and demonstrate a technology embodying the requirements as outlined above and demonstrate the capability of packaging the required energy contents, safely into the mass and volume restrictions identified. Demonstration devices need not be fit-form of the final system, but should show how the technology can be modified to accommodate the ideal system requirements.

PHASE II: Implement a practical demonstration (prototype) power source compatible with existing hardware, power levels, and performance endurances under temperature extremes and meeting the requirements of airborne and underwater deployment scenarios.

PHASE III: Refine the power source and demonstrate compatibility with airborne and submarine deployment platforms.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A practical and scaleable “wooden-round” primary power system capable of instant power generation upon activation that meets the energy and power density requirements listed above for volumetric, gravimetric and heat loading, can be utilized as emergency power generation systems for civilian transport operations (commercial aircraft, boats, automobiles), can be used for disposable ROV power for emergency rescue and surveillance and would be practical for internal carriage in aircraft and submarine as auxiliary power for stores.

REFERENCES:
1. NAVSEA INST 9310.1b of 13 June 1991
2. NAVSEA Technical Manual S9310-AQ-SAF-010 of 20 July 1988
3. MIL-STD-2105B 12 January 1994 Hazard Assessment Tests for Non-Nuclear Munitions

KEYWORDS: UUV; ROV; battery; power source; safety; mine countermeasures; MCM; fuel cell

N04-051 TITLE: Advanced Forward Looking Sonar for Unmanned Vehicles

TECHNOLOGY AREAS: Sensors, Battlespace

ACQUISITION PROGRAM: Remote Minehunting System (RMS)

OBJECTIVE: Develop and evaluate a prototype forward looking sonar (FLS) sensor package, suitable for use on unmanned vehicles, that employs advanced sensor technology to support littoral warfare mine warfare and anti-submarine warfare mission products, such as mine detection, swimmer detection, submarine detection and obstacle avoidance particularly in shallow water, where the FLS is housed in a vehicle that is submerged just below the water surface.

DESCRIPTION: The remote minehunting system, AN/WLD-1(V)1, is being developed by the USN to provide an organic mine reconnaissance capability to forward operating forces in the battlegroup. Addition of an FLS to the remote minehunting vehicle component of the system will provide the vehicle itself with enhanced obstacle avoidance capability. A variety of advanced technologies have matured in the past several years that, individually or in combination, can be exploited to address this technology requirement. What is needed is an advanced-technology sensor package that can operate from standoff ranges of 20-500 yards, a vertical beam of 5-20 degrees, and horizontal beams to 45 degrees off bore sight. The FLS should yield data that enhances the performance of the RMS through environmental measurement, improve detection of mine targets, potential vehicle obstacles, improve target recognition and discrimination, and have the ability to detect submarine targets. Offerors are encouraged to use synergy from existing concepts like swimmer detection, mine detection and obstacle avoidance systems to develop a rapid and cost effective capability. The Navy will only select proposals that are innovative, address R&D and involve technical risk.

PHASE I: Develop a design for a sensor package. Provide a quantitative assessment of the anticipated performance of this sensor package in an Intelligence, Surveillance, and Reconnaissance (ISR) role.

PHASE II: Build and test the prototype sensor package, through proof-of-concept demonstration.

PHASE III: Transition to the FLS to AN/WLD-1 where the sensor package will undergo testing in an operational AN/WLD-1.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Remotely operated and unmanned underwater vehicles used for salvage operations, accident debris location, underwater mapping, environmental hazard surveys, and similar operation are often equipped, individually or in some combination, with video cameras, side scan sonar, or non-acoustic sensors. Addition of this Forward Looking Sonar to the suite of available sensors would provide such vehicles with an extra measure of protection and the capability to operate more efficiently.

REFERENCES:
1. Future Naval Capabilities Website http://www.onr.navy.mil/fncs/
2. AN/WLD-1(V)1, Remote Minehunting System (RMS) Website. The URL will be available through SITIS under this topic number.

KEYWORDS: remote minehunting system, RMS, forward looking sonar, FLS, mine warfare, anti-submarine warfare, ASW, obstacles, battlespace environment

N04-052 TITLE: Expendable Array Installation System

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT I: Advanced Deployable System (ADS) Program

OBJECTIVE: Develop a modular expendable installation system, to be launched from a surface platform, for deploying an underwater acoustic array.

DESCRIPTION: The installation system would most likely be a module for the Littoral Combat Ship (LCS) because of its mission, but the system, being modular, could also be launched from other surface platforms. LCS, currently in development, is envisioned to be capable of high speed. An expendable installation system capable of being launched by LCS would enable the ship to place a number of sensors on the seabed without having to slow down as would be the case if the ship itself was the installation system. A single array load-out for an expendable installation system, based upon the Advanced Deployable System (ADS) array, would be ~200 lbs and would have ~1 km of extent on the ocean bottom. Two arrays with fiber optic interconnect cable between them would be ~800 lbs and would have ~10 km of extent on the ocean bottom. Upon launch, the installation system would consist of a radio buoy, an underwater processing/power segment, and the array/cable segment. The buoy and processor segments would separate from the array segment at water entry. The array installation segment would then swim away from the buoy/processor position and install arrays and cable linearly on the seabed. The buoy and processor portion of this system can be developed through normal engineering practices. The array installation segment imposes technological challenges of operating autonomously in very close proximity to the ocean bottom and being able to deploy sensors and cable while doing so. The array installation segment must also be inexpensive when produced in quantity.

PHASE I: Develop the design for an array installation capability. The design of the array installer must permit operations in all littoral ocean areas and the currents encountered there, survive shock effects of the deployment and installation process, and be highly reliable. The installer must be capable of laying an array and cable with an autonomous, fire and forget, disposable mechanism. This mechanism must be able to install the array within a corridor that is 25 meters wide over the length of the array and cable. Innovation in developing these capabilities and yet have the unit be inexpensive enough to be expendable is required. For the Phase 1 option, it is recommended that the design be shown to meet goals of installing, (a) a 1 km cable/array on the seabed, and (b) a 10km cable/array (consisting of two arrays and interconnect cable) on the seabed.

PHASE II: Build and test an array installer capable of installing a dummy array payload. Determine how the array installation segment would interface to the buoy and processor segment so that they could be launched as a unit or separately. Notional properties of the buoy and processor segment are - a radio buoy (1ft diameter x 10 feet long), Batteries/power system (~50 KWhr's), underwater processing segment (1 ft diameter x 1.5 ft length), and riser cable with expandability multiple water depths.

PHASE III: The developer of the expendable array installation segment would participate in the ADS Concept Development and Demonstration program for developing the ASW mission module for LCS. Starting in FY06, the ADS program will begin testing the sensor installation portion of the mission module. Successful completion of a SBIR Phase II effort would allow the contractor to become a member of the ADS testing team.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This topic is intended to develop a technology that would be a component of a mission module for LCS. Commercialization in the private sector would need to be researched but would undoubtedly involve installation of remote sensing equipment.

KEYWORDS: array installation; expendable module; acoustic array; Advanced Deployable System; ADS; Littoral Combat Ship; LCS; ASW

N04-053 TITLE: Advanced Pressure-Tolerant UUV Batteries for Fleet Use

TECHNOLOGY AREAS: Ground/Sea Vehicles, Electronics

ACQUISITION PROGRAM: Unmanned Underwater Vehicle (UUV)

OBJECTIVE: Develop and characterize pressure-biased lithium-ion polymer rechargeable batteries for adaptation to tactically deployed submarine and surface-ship launched UUVs for variable depth operation, which will enable safe, rapid, wet-recharge capability without UUV disassembly.

DESCRIPTION: The Navy's Unmanned Undersea Vehicle (UUV) Master Plan [April, 2000] cites numerous missions that must operate in littoral shallow-water environments. Existing and evolving mission needs of extended UUV endurance and on-station time drive the desire for increased stored energy densities. In addition, desired reductions in per-sortie and life-cycle costs require new and innovative approaches to energy system replenishment without extensive, time-consuming UUV disassembly/reassembly. As Navy programs plan towards development and introduction of larger, reconfigurable UUVs with increased payload capability and energy capacity, cost-effective energy approaches must be pursued. Current primary batteries and developmental one-time use energy sources provide high energy densities, but require labor-intensive turnaround and have relatively high operating costs. Advanced rechargeable lithium batteries offer attractive performance, cost, and recharge times, but face significant challenges for gaining safety certification for use on board submarines and surface craft.

Since UUVs are typically power and volume constrained platforms, any concepts must be engineered for efficient and compact operation. Weight and volume allocation should be compatible with mounting within various UUV characteristic shapes (various typical shapes include 21" dia cylinders, 2800 lb displacement; <8" dia cylinders, ~100 lb displacement; and >> 21" profiles, 5-10 ton displacement or larger). Rechargeable Lithium batteries are used in many applications today, including cell phones, PDAs, cameras, etc., but require near atmospheric conditions to survive. Flooded/pressure-tolerant battery designs offer increased capability. With a flooded/pressure tolerant battery, hull section could be reduced, thereby, decreasing weight and increasing space and flexibility in the vehicle. This new battery design would have impacts on both military and commercial UUV and other submerged equipment. Batteries may be used in conjunction with other power conversion hardware in hybrid-system concepts. Safety characterization for full-sized battery systems to gain approval for use on-board manned Navy platforms is a desired outcome of this effort.

PHASE I: Design Evaluation and Concept Modification. Evaluate current commercial and new battery designs in light of the test protocols set forth in NAVSEA Technical Manual S9310-AQ-SAF-010 and its proposed revision. Identify any and all potential failure modes of the battery under those demanding tests, and estimate both the likelihood of the failure occurring and the consequence of that failure. Provide designs that will mitigate identified failure modes. Battery design concepts should be aimed at providing a form-fit-function adaptation to the AN/BLQ-11 energy system for training and mission deployment purposes; as well as for modular designs for emerging large displacement UUVs (GFI on interfaces can be provided). Battery system energy densities should be 100 Whrs/kg or greater (200 Whrs/kg or greater desired).

PHASE II: Fabrication, Engineering Tests, Design Adjustments, Safety Tests. Fabricate scaled and full-sized prototypes of the selected/modified batteries. Conduct engineering tests under pressure and under the relevant sections of the testing protocol set forth in NAVSEA Technical Manual S9310-AQ-SAF-010 and governed by NAVSEAINST 9310. Use the results of the engineering tests to make any design adjustments required, and subject a select number of completed batteries to a full set of performance and safety tests in house. Navy battery safety/test personnel may perform selected tests at Navy Laboratory facilities (TBD). If fully successful at the end of Phase II, a design for a high-performance, pressure-tolerant battery will be demonstrated as operationally safe and acceptable under the S9310 lithium battery safety test process.

PHASE III: Commercialization. Upon the successful completion of Phase II, the Navy would opt to procure a small number of units required for formal follow-on testing under S9310-AQ-SAF-010 and UUV program integration testing, at-sea experimentation, and low-rate production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: UUVs and Remotely Operated Vehicles (ROVs) are increasingly capturing commercial applications such as ocean exploration, mapping, salvage, and oil and gas surveying markets. Energy sources developed for military applications may provide valuable cost savings to commercial uses.

REFERENCES:
1. The Navy Unmanned Undersea Vehicle (UUV) Master Plan, April 20, 2000

KEYWORDS: unmanned undersea vehicle; UUV; lithium-ion batteries; lithium polymer batteries; pressure-tolerant batteries; lithium battery safety.

N04-054 TITLE: Multiple Secure Level Simulation Federation Technology

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO IWS: Advanced Ship Combat System Engineering

OBJECTIVE: Develop the infrastructure elements to execute multi-security level simulation federations of combat systems.

DESCRIPTION: Increasingly, national and international organizations are relying on a standards-based simulation infrastructure to interconnect simulation capabilities, to increase simulation interoperability and control modeling and simulation (M&S) costs. The High Level Architecture (HLA) has emerged as the Department of Defense (DoD) and multinational standard of choice for simulation infrastructure. Developed by DMSO on behalf of DoD, the HLA has been adopted by the Institute of Electrical and Electronics Engineers as the IEEE Standard 1516 family, and now adopted as the NATO simulation standard. However, the HLA currently does not provide for federations of simulations operating at different security levels. The entire federation must operate at the highest security level contained by the federation. This effort will develop the infrastructure components that will allow for simulations of a federation to operate at different security levels and receive only the information for which they are cleared.

PHASE I: Identify the key technical issues and design infrastructure elements required for efficient implementation of multi-level federation data security. Develop the design for implementing a multiple secure level federation of a combat system.

PHASE II: Implement the design of Phase I. Demonstrate its versatility by applying it to two different federations. Package and document the technology for general use by the M&S community.

PHASE III: The immediate utilization for this technology resides with the simulation community. Implement it in the combat systems engineering Probability of Raid Annihilation (PRA) distributed simulation testbed to demonstrate viability in practical applications. Pursue collaborative efforts with industry to safely exercise proprietary models in Navy combat system federations. Additional applicability would be in support of the Joint Distributed Engineering Plant, the Joint National Training Center, and Simulation Based Acquisition.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology can be used to facilitate collaborative efforts between industries while protecting their proprietary information.

REFERENCES:
1. Kuhl, Weatherly, and Dahmann, "Creating Computer Simulation Systems An Introduction to the High Level Architecture", New Jersey: Prentice-Hall, Inc., 1999.

2. "IEEE Recommended Practice for High Level Architecture (HLA) Federation Development and Execution Process (FEDEP)", IEEE Std 1516.3TM, Institute for Electrical and Electronics Engineers, New York, 2003.

KEYWORDS: Simulation; security; multi-level; HLA; federation; networks

N04-055 TITLE: Electromagnetic Susceptibility Threshold Distributions Tools for Electronic Systems

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: NON ACAT S-BAND RADAR (SBAR)

OBJECTIVE: Develop analysis tools including software applications and models that will provide an optimized test and analysis methodology for characterizing the electromagnetic susceptibility threshold distributions for electronic systems.

DESCRIPTION: Most electronics systems developed for military operations must pass a MIL-STD electromagnetic (EM) susceptibility test at specified field levels. The current EM susceptibility or immunity standards involve a pass/fail test. However, no susceptibility distribution data are obtained. The absence of this data prevents an assessment of the probability of effect for a given EM stress level. This is of particular concern because of environmental issues impacting personnel exposure times when they conduct the tests for high power radars(i.e., 15 dB more than legacy rf sensors). This effort will develop and validate analytical tools as well as an associated optimized methodology, including both analyses and test procedures, for evaluating EM susceptibility threshold distributions.

PHASE I: Design innovative analysis tools and define associated test procedures, which demonstrate the feasibility of predicting EM, susceptibility margin distributions for high power rf systems.

PHASE II: Develop initial software packages to include test procedures, data acquisition and data analysis. Then, validate the utility of the analysis models, test procedures, and assessment methodology. Demonstrate the validity through EM testing of multiple units of several classes of electronics systems.

PHASE III: Develop validated software packages for use by military and commercial agencies. Provide system assessment service to military and commercial agencies.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability will enable electronic manufacturers and system operators to assess the probability of failure for subsystems/components when used in a variety of systems at different EM stress levels. The capability will be of particular value to organizations that must perform risk analyses for systems in which a failure would significantly impact personnel, equipment or environment. It also will permit evaluation of the effects of changes in the threat environment as well as changes in system shielding effectiveness due to redesign, maintenance, or aging.

REFERENCES:
1. M. Ladbury, T.H. Lehman, and G.H. Koepke, "Coupling to Devices in Electrically Large Cavities, or Why Classical EMC Evaluation Techniques are Becoming Obsolete", IEEE Symposium on EMC, Minneapolis, MN, August 2002, p648-655

KEYWORDS: Electromagnetic; Susceptibility; Immunity; Failure threshold; COTS; Electromagnetic Effects; EMI; EMC; TEM Cell; Reverberation Chamber; Radiated Emissions; Radiated Immunity; RF; High Power RF

N04-056 TITLE: Alternatives to Thermal Battery Power Supply for Missiles

TECHNOLOGY AREAS: Materials/Processes, Electronics, Weapons

ACQUISITION PROGRAM: Extended Range Active Missile (ERAM)

OBJECTIVE: Develop novel methods of power generation to replace thermal batteries for missiles and/or enhance existing power generation within constraints of weight and volume.

DESCRIPTION: Currently power for missile sub-systems is provided by thermal batteries. DoD has identified thermal battery technology as a critical military problem that demands significant attention. There have been no major thermal battery improvements since 1980. The electrical power demands of new weapon systems are exceeding the technology limits of present thermal batteries and it is not likely that the desired improvements will come from present thermal battery systems. There are various missile applications where improved power supplies are in demand by the Navy. These improvements are: higher cell voltages; higher energy and power densities; and longer operating lifetimes. It is desirable to evaluate other innovative sources and concepts for electrical power to meet the need for future weapons systems and/or eliminate/reduce the need for thermal batteries.

Desirable power characteristics include voltages from 8 to 170 Volts, amperages from between 1 and 84 Amps and power from 100 to 14,000 Watts.

PHASE I: Conduct feasibility analyses, technical modeling and simulation, or small-scale proof-of-concept efforts, according to proposed innovations and improvements. Voltages, amperages, power and other performance properties should be considered and measured, where applicable.

PHASE II: Implement technology assessed in Phase I effort. Phase II effort should include fabrication of prototypes and demonstration of power generation capabilities to provide required power. Full testing and verification of performance properties should be included.

PHASE III: The contractor will finalize the technology associated with the innovative methods of power generation and prepare for flight testing and commercialization.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Electrical power harvesting for extending small volume battery life has commercial potential in the consumer appliance industry, security and surveillance industry, transportation industry, aerospace industry, and maritime industry. One specific potential military application is for power generation on small surface and sub/surface vessels where space limitations restrict generator placement.

REFERENCES:

1. LIR FY 2001 Abstracts; on-line at http://www.onr.navy.mil/sci_tech/special/docs/fy01_abstracts.doc
2. FY 00 ILIR Program Potential Fleet Impacts; on-line at http://www.onr.navy.mil/sci%5Ftech/special/docs/fleetimpactfy00.doc

KEYWORDS: thermal battery; electric power generation; missile power supply

N04-057 TITLE: High Power Phase Shifters

TECHNOLOGY AREAS: Materials/Processes, Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: NON-ACAT S-Band Radar (SBAR)

OBJECTIVE: Develop innovative high power phase shifters for modern phased array radars.

DESCRIPTION: Future Navy radar systems require high power levels per array element, high stability, and rapid beam switching. Current high power phase shifter technologies require unattractive compromises in terms of losses, switching speed, and/or cost. Concepts, devices, materials, and advanced technologies for all types of high power phase shifter topologies that can satisfy projected shipboard radar system requirements are sought. The primary frequency of interest is S-band however other frequency bands are also of interest. The ideal phase shifter would offer reduced losses and improved power handling capability relative to ferrite phase shifters, with the switching speed of semiconductor phase shifters. Of particular interest is the application of wide bandgap semiconductor switch devices to high power phase shifters.

PHASE I: Identify, design, and model the performance of new and innovative approaches to meet the high power phase shifter needs discussed in this topic.

PHASE II: Develop applicable and feasible prototype demonstrations and/or proof-of-concept devices for the approach described.

PHASE III: Develop pre-production and production components and sub-systems for integration into Navy advanced radar systems and identify commercial applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These technologies could be applied in many RF applications such as the telecommunications industry, commercial airport radar systems, and automotive industry.

REFERENCES:
1. R. Kirschman (ed.), “High-temperature electronics”, IEEE Press (New York, 1999).
2. P.L. Dreike et al., “An overview of high-temperature electronic device technologies and potential applications”, IEEE Trans. on Components, Packaging and Manufacturing Technol., pp. 594-604 (1994).
3. Weimer, “Thermochemistry and Kinetics”, Carbide, Nitride and Boride Materials Synthesis and Processing, edited by A. Weimer, Chapman and Hall, New York, 79-113, (1997)
4. Koul, S., Bharathi B., Microwave and millimeter wave phase shifters, Artech House, 1991

KEYWORDS: Radar; Phase shifter; High Power; Wide Bandgap; Wide Bandwidth; ferrite

N04-058 TITLE: MMIC Coatings and Encapsulation for Non-Hermetic, Low Cost, Transmit/Receive Modules with the Reliability of Hermetic Packaging

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: NON-ACAT S-Band Radar (SBAR)

OBJECTIVE: Develop innovative non-hermetic alternatives to hermetic packaging that meets the Military requirement for resistance to moisture-induced failures and meets MIL-STD-883E Device Screening and Qualification.

DESCRIPTION: Future L, S and X-Band, phased array radars will be using T/R Modules that are currently very expensive due, in part, to hermetic packaging costs. Passivation and Encapsulation processes that allow for non-hermetic packaging, and meet environmental and performance requirements are to be developed. Hermetic-like MMIC, IC, transistor and diode coatings added at wafer level processing with no impact to wafer testability, and with acceptable RF performance are to be developed. And, added at circuit board integration level, with acceptable RF performance. Together, or separately, the wafer, and circuit board passivations and encapsulates will ultimately provide the same level of long term protection as hermetic packaging, and meet the following screening requirements: Device Screening MIL-STD-883E, Method 5004 and Method 5005.11 Device Pre-Conditioning JESD22 Method A113 Level 1 HAST @ 140 Degrees C, 85 % RH (minimum 1000 hrs) Temperature cycling MIL-STD-883E Method 1010.9 And Salt Fog, JESD 22-A107-A.

PHASE I: Design, model, and/or demonstrate non-hermetic packaging techniques meeting the intent of this topic.

PHASE II: Develop prototype coatings, passivations, and encapsulates, and processes. Demonstrate stable device performance and meet, or exceed the above specified goals. Develop and demonstrate new processes (or hardware) that lead o production of non-hermetic T/R Modules.

PHASE III: Prepare detailed plans to implement demonstrated capabilities on critical military and commercial applications. Produce production quality materials, coatings passivations, encapsulates that lead to non-hermetic T/R Modules.

PRIVATE SECTOR COMMERCIAL APPLICATIONS: Advanced coatings, passivations and/or encapsulates that allow non-hermetic packaging of T/R Modules will have throughout commercial industries. Commercial radars, automobile electronics, communications equipment, cell phones, satellites and the electrical power industry would benefit from this development.

REFERENCES

1. M.J. Loboda, R.C. Camiletti, L.A. Goodman, L.K. White, H.L. Pinch, J. Shaw, V.K. Patel, C.P. Wu, and G.M. Adema, "Chip Scale Packaging with Reliability for MCM Applications", Proceedings of the 1996 ISHM Conference on MCMs. Available online at website http://www.waspp.org/presentations/chipscale.pdf
2. R.C. Camillett and M.J. Loboda, "Thin-Film Packaging For MCM Applications" Published in the ISHM 1995 Technical Program at the 4th International Conference & Exhibition on Multichip Modules. Available online at website http://www.waspp.org/presentations/thinfilm.pdf
3. M.J. Loboda, R.C Camilletti, L.A. Goodman, L.K. White, H.L. Pinch, C.P. Wu, "Manufacturing Semiconductor Integrated Circuits With Built-In Hermetic Equivalent Reliability". Published in the Proceedings of the 1996 ECTC Symposium. Available online at online at website http://www.waspp.org/presentations/semiconductor.pdf
4. Sze, S.M., Physics of Semiconductor Devices, john Wiley & Sons 1981
5. White, J. F., Microwave Semiconductor Engineering, Van Nostrand Reinhold Ltd. 1982

KEYWORDS: Non-hermetic packaging; MMIC passivation; circuit board encapsulate; Transmit/Receive Module; Si; GaAs; SiC and GaN transistors; MMIC; Schottky diodes; PiN Diodes; X-band; S-band; L-band; Radar; EW; Communication Equipment

N04-059 TITLE: Exoatmospheric Attitude Control System For Very Long Range Projectiles

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: Naval Fires Control System (NFCS)

OBJECTIVE: Develop a very compact and rugged attitude control system to maintain "nose first" attitude for projectiles that travel outside the atmosphere.

DESCRIPTION: Very long range projectiles for Naval Surface Fire Support, fired by either chemical or electromagnetic guns, achieve altitudes that are essentially outside the atmosphere. Specifically, they travel high enough that atmospheric forces are insufficient to stabilize the projectile, and result in a reentry at a high angle of attack, leading to inaccuracy, instability, and potentially tumbling. This topic seeks the application of innovative technology to a reaction control system that can torque a projectile into nose-first attitude for reentry.

The current technology of choice, a valved gas bottle, is undesirable for this application, since it is complex and expensive, requiring a fast-acting valve actuator, machined nozzles, and piping. To meet insensitive munitions requirements, the gas bottle must have a pressure relief feature that will vent the gas when exposed to fire, but not fail under the loads of gun launch. This topic seeks innovative alternatives to a valved gas system to produce a reaction system that is smaller, more rugged, and more reliable.

One potential technology that could be applied to this type of innovative reaction system is the use of porous silicon infused with gadolinium nitrate to produce "silicon gunpowder", as described in Reference (1). (This example is not meant to restrict the topic to this approach, but to illustrate the type of novel approach desired, and to provide a more concrete example of underlying technology, to better discuss the private sector commercial potential). Using this technology to develop a multiple-popper or multi=pulse jet component would produce the type of compact, rugged, and low cost system needed.

PHASE I: Develop a design for the attitude control system. The system should be sized to provide torque sufficient to rotate a 100 kg projectile with an angular moment of inertia of 4.42 kg m^2, 90 degrees on its pitch axis in 270 seconds and then reduce the pitch rate to the needed reentry rate to a tolerance of 0.3 degrees/second and achieve a zero-degree reentry angle of attack within 3 degrees. The projectile will be rolling at about 15 Hz; this roll must be accounted for, and can be used to simplify the system. Assume that position, attitude, and angular rates are available from the projectile's GPS/INS navigator. The system design must be suitable for gun launch at 12,000 gees.

PHASE II: Develop and test the attitude control system. Demonstrate its ability to achieve the specified rotation rate and reentry attitude and pitch rate.

PHASE III: The attitude control system will be part of very long range fire support projectile intended as a follow-on to the current EX-171 Extended Range Guided Munition, and needed when shipboard electromagnetic rail guns are deployed. Marry the control system to the projectile.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Reaction control systems themselves are needed in commercial exoatmospheric systems such as sounding rockets and satellites. One example of such a commercial application was the HyShot experiment conducted by the University of Queensland to demonstrate a supersonic combustion ramjet. (See http://www.uq.edu.au/news/multimedia/hyshot_description.html)

The HyShot trajectory exits the atmosphere, the valved gas bottle reorients the rocket to be nose-first for reentry, and the experiment runs as the rocket penetrates the atmosphere. In the HyShot experiment, the reaction system was hand-built and so very expensive, and occupied valuable volume in the airframe.

In more general terms, the reaction-producing technology used to produce this attitude control system has applicability to produce propulsion for MEMS sensor systems and similar small robots and as an energy source for MEMS chemical sensors or for a handheld unit for flame emission spectrometry

REFERENCES:
1. Computer Chips Found To Possess Explosive Properties Useful For Chemical Analysis And Nanoscale Sensors. University of California, San Diego press release, January 9, 2002. Available on the Internet at http://ucsdnews.ucsd.edu/newsrel/science/mcporous.htm

KEYWORDS: reaction control; attitude control; thruster; exoatmospheric; thruster; silicon gunpowder

N04-060 TITLE: Low Cost Modular Control and Actuation Systems

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Development of low cost modular control and actuation systems

DESCRIPTION: There is a need to develop new mechanical, electrical, and communications approaches for the aerodynamic control and control surface actuation systems of missiles and guided munitions. , The currently used systems require extensive integration efforts for each new application. This situation prevents the rapid prototyping and prevents the low rate production of novel concepts. Often concepts cannot be demonstrated because of the cost of integrating mid-level performance actuators. Market surveys repeatedly indicate that such a system is not available as a procurement item.

Required approaches must yield modular ("plug and play") and self-contained aerodynamic control and control surface actuation systems that are robust enough to withstand the gun launch loads, can be easily inspected separately from other critical components such as the warhead and rocket motor, and use standardized interfaces that allow low cost integration with current and new missiles and guided munitions. Required systems must ensure the deployment and locking of control surfaces immediately after launch, very fast response rates to the control system commands, and low power requirements. These approaches must be oriented to low to mid performance applications, modular designs incorporating other electronic equipment, and allow low unit cost through large production runs.

PHASE I: Design the aerodynamic control system. Develop low cost approaches to the control surface deployment, locking, and actuation. Apply innovative "design for manufacturing" approaches to create a design suitable for low-cost production needed for an R&D effort. Develop a numerical simulation for the dynamics of the proposed aerodynamic control system and evaluate its expected performance.

PHASE II: Fabricate a prototype of a low cost modular system and demonstrate its performance through bench testing. Demonstrate (via bench testing) its ability to be reconfigured for different applications. Estimate manufacturing cost.

PHASE III: Demonstrate the design suitability for gun launch though air gun, and canister launches using, for example, the NSWC Dahlgren 8-inch test canister. Test the in-flight response of the prototype using an existing missile or projectile airframe shape in wind tunnel or captive carry flight. Refine the design and model to incorporate the results of the gun launch and in-flight test.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This topic admits a wide range of different technical approaches and areas for innovation. Of these, the topic writers believe the following technologies will be important. They are listed along with their private sector commercial potential
1. Control surface trimming and leading and trailing edge boundary layer spoiling, which is directly applicable to both general and commercial aviation.
2. Flexible design-manufacturing processes, including rapid prototype buildup, to go “from screen to part”. These processes apply especially to product development in a “mindshare grabbing” economy, where the first product to market becomes the defacto standard.

REFERENCES:
1. ERGM Fact Sheet http://www.raytheon.com/products/ergm/ref_docs/ergm.pdf
2. Shih, Chiang and Chih-Ming Ho “Recent Advances of MEMS Applications In Flow Control.” 2000 http://www.eng.fsu.edu/~shih/homepage/India%20invited%20talk%202000.pdf
3. Tsao, Thomas, Fukang Jiang, et. al. “An Integrated MEMS System for Turbulent Boundary Layer Control.” 1997 International Conference on Solid-State Sensors and Actuators (Transducers 97), June 1997 http://touch.caltech.edu/publications/tomster/trans97/transducers97.pdf
4. Grosjean, C. “Micro Balloon Actuators For Aerodynamic Control” http://touch.caltech.edu/publications/charlesg/mems98/mems98.pdf
5. Womack, James P., Daniel T. Jones, Daniel Roos. The Machine That Changed the World : The Story of Lean Production. HarperPerennial, 1991, ISBN 0-06-097417-6

KEYWORDS: Actuator; Flight, Dynamics, Stability, Control; Tactical; Ballistic; Missile

N04-061 TITLE: <u>Guidance Laws for Reduced Seeker Field of View Requirements</u>

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop guidance laws that permit reducing a missile seeker’s required field of view

DESCRIPTION: Innovative guidance algorithms that allow the line of sight from the missile centerline to the target to be explicitly controlled during the final few seconds of the flight are in demand. Control of this line of sight angle allows the increased use of body fixed seekers for a wide range of missions and guided munitions. Availability of such algorithms would result in a reduced field of view requirement for a body fixed seeker, which would allow increased sensitivity for the seeker and increased detection range without increases in seeker technology. This results in increased seeker performance through merely software changes.

PHASE I: Develop and mathematically model the guidance laws and algorithms proposed to explicitly control the line of sight. Test the response, reliability, and performance of proposed laws and algorithms using computer simulations.

PHASE II: Demonstrate the performance of proposed guidance laws and algorithms in a simulated virtual environment using a missile guidance test bed such as those described in the references.

PHASE III: Demonstrate the performance of proposed guidance laws and algorithms in captive carry and in-flight modes using a designated missile or guided projectile.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology of this topic is applicable to commercial aviation mid air collision avoidance systems and software and to highway safety systems.

REFERENCES:
1. D. B. Beasley et al, "Current Status of the Laser Diode Array Projector Technology," Optical Sciences Corporation, http://www.opticalsciences.com/Engineering/projectors/Papers/SPIE98c.pdf
(Describes the US Army Aviation and Missile Command's missile guidance test bed.)
2. Jeff L. Page et al "Designing Motion Systems for Hardware-in-the-Loop Simulation," Carco Electronics. http://ducati.doc.ntu.ac.uk/uksim/papers/zobel/Page-new.doc

KEYWORDS: Seeker; Ballistic; Missile; TIA Modules Guidance, homing

N04-062 TITLE: Electronic Warfare (EW) Systems Antenna Enclosure concepts

TECHNOLOGY AREAS: Materials/Processes, Weapons

ACQUISITION PROGRAM: Surface EW Improvement Program (SEWIP)

OBJECTIVE: Provide US Navy EW Systems with improved antenna enclosures to meet future installations and system upgrade requirements.

DESCRIPTION: Current EW System antennas are highly susceptible to both shipboard Electromagnetic Interference (EMI) and corrosion. The Navy has a need for an innovative, cost effective replacement of the EW system antenna enclosures to meet an extended service life as well as new construction installations.

The existing Electronic Warfare antenna enclosure is designed to provide environmental protection for the direction finding and semi-omni antennas utilized by the system to perform its mission of detection, location and countermeasures. The design consists of a welded, riveted aluminum frame with fiberglass matte panels and doors. The doors are reinforced by aluminum channels and sealed with a rubber gasket that is friction sealed to the walls of the enclosure sides. The interior components are shielded within their units and the cables have internal shielding to protect against electromagnetic interference from other ship's electronics. The antenna designs are currently entering their third decade of service and are expected to be in service for a period of another three decades.

The combination of aircraft grade aluminum, stainless steel mounting hardware, saltwater, and other metals in the construction of the antennas creates a galvanic cell resulting in severe corrosion. The fiberglass matt panels are deteriorating due to the length of service, exposure to the sun, damage from external trauma, and repeated recoating. In addition, modern ship design has resulted in an increased usage of electromagnetic generating systems. The Electromagnetic Interference (EMI) thus generated has created a significant increase of interference problems with antenna and overall system operation. The design of the antenna housing is extremely labor intensive. Current repair and reproduction of the antennas is not cost effective due to the complicated nature of the construction process.

The goal of the effort is to provide an innovative antenna enclosure design utilizing state-of-the-art materials including, but not limited to, composites, plastics and other materials with simplified fabrication methods allowing components to be housed and protected not only from the environment but from a broad spectrum of high energy RF wave interference. A premium will be placed on service life between required maintenance. Successful designs will eliminate galvanic cell creation and other forms of deterioration resulting from long term exposure to a saltwater environment and extended ultraviolet exposure with extreme temperature changes. The design must comply with all required military environmental, EMI specifications, and not interfere with system performance requirements. Performance issues that should be improved upon include improved Electromagnetic Interference (EMI) attenuation and reduced Radar Cross Section (RCS).

PHASE I: Explore innovative concepts and environmentally safe materials for enclosures that meet the shipboard environmental requirements, effectively reduce EMI penetration, reduce RCS, and address dissimilar material issues. Design and model candidate concepts that will meet these requirements.

PHASE II: Build samples of candidate materials and demonstrate through laboratory testing the material's ability to meet requirements for EW Systems antenna enclosures. Provide cost model for candidates.

PHASE III: Develop a production model and qualify it for shipboard use. Determine commercial viability and applicability in commercial sector.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology has the potential for utilization in areas that have a need for marine resilient enclosures for any maritime shipboard system application, whether it is private or commercial platforms.

REFERENCES:
1. MIL-STD 810 – Environmental Engineering Considerations and Laboratory Tests
2. MIL-S-901 Shock Tests - Shipboard Machinery, Equipment, and Systems, Requirements for
3. MIL-STD- 167-1- Mechanical Vibrations of Shipboard Equipment
4. MIL-STD-461 - Requirements For The Control Of Electromagnetic Interference Characteristics Of Subsystems And Equipment

KEYWORDS: Shipboard environment; Lightweight; Durable; EMI attenuation; Radar Cross Section

N04-063 TITLE: Undersea Small Object Avoidance

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Surface Ship USW Combat System

OBJECTIVE: Develop and demonstrate new techniques for tactical surface ship small object avoidance (in-stride mine avoidance)

DESCRIPTION: Surface ship mission effectiveness requires an ability to transit and operate in hostile environments, including waters that have not been cleared of enemy mines. Current mine detection processing techniques operating in conjunction with the SQS-53 series active hull mounted sonar are unable to provide robust detection and small object classification capability to ensure safe tactical surface ship operations. The SQS-53 Kingfisher capability uses broadband active waveforms with short pulse lengths to improve small object detection. Recent at-sea exercises using these techniques have not provided satisfactory detection and localization performance over the range of ship speeds and littoral acoustic environments in which tactical ships must operate.
New techniques must provide quantitative improvement in probability of detection, small object localization accuracy, and small object classification capability. The proposed technology must also severely limit the rate of incorrect alarms of mine detection, since false alarms may initiate inappropriate tactical response.

PHASE I: Characterize current surface ship small object detection performance using existing sea test data and leveraging on-going Navy sea tests. Define a technical concept and candidate processing algorithms for detection, classification, and localization of small objects for tactical surface ships. Develop models of the proposed approach and quantify the performance benefits relative to existing system capability. Technical performance metrics to be evaluated shall include probability of detection (Pd) and probability of correct classification (Pcc).

PHASE II: Develop a prototype small object avoidance capability and integrate into an analysis processing architecture. Demonstrate small object detection, classification, and localization performance using at-sea data recordings from a realistic surface ship operational environment.

PHASE III: Transition the improved small object avoidance system into the operational surface ship USW combat system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Small object detection and classification systems would benefit commercial fishing, undersea exploration, and undersea search and recovery technologies.

REFERENCES:

1. Lyons, H. Dwight; Eleanor Baker; Sabrina Edlow; and David Perin. The Mine Threat:Show Stoppers or Speed Bumps?, Center for Naval Analyses, 1993.
2. Sutter, Fred and Diane Cushmen. "Mine Countermeasures Tactical Models." Proceedings of the Autonomous Vehicles in Mine Countermeasures Symposium. Naval Postgraduate School, April 1995.
3. U.S. Navy Mine Countermeasures Familiarizer, Naval Mine Warfare Engineering Activity, October 1991.
4. NAVSEA Mine Familiarizer, Naval Mine Warfare Engineering Activity, April 1985.

KEYWORDS: Acoustic Sensors; Undersea Warfare; Automation; Signal Processing

N04-064 TITLE: Automated Situational Awareness Technology for Collision Avoidance

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT I: Virginia Class Sub

OBJECTIVE: Design and develop new automated algorithms/models that can increase recognition of targets within a specified area; as well as, provide classification (friend or foe)and localization information of the recognized targets to Submarine Sonar and Combat operators in high clutter environments. These efforts will improve tactical decision making and reduce Submarine's potential for collision.

DESCRIPTION: As the number of surface craft grows, SONAR operators' task of quickly identifying, localizing, and classifying contacts becomes more difficult. Current automation has difficulty isolating contacts in cluttered environments and following contacts during own-ship turns. To assist the operators, new algorithms and models need to be developed which automate contact management and the processes required in recognizing contacts of interest and avoiding collisions in high density contact areas. This topic seeks new algorithms and models for automated contact detection, classification, and localization (DCL). These models and algorithms should be modular and easily integrated into existing real-time commercial of the shelf (COTS) hardware platforms.

PHASE I: Develop and design algorithms /models that enhance the Sonar operator's ability to recognize, localize and classify a target or contact of interest. At the end of Phase I, a high level design and technology profile should be provided that specifies interfacing data requirements and minimal hardware performance requirements.

PHASE II: Demonstrate the models/algorithms ability to improve classification, localization, and detection in a laboratory environment with at-sea data.

PHASE III: Transition software to Navy submarines acquisition offices for use in the fleet. Commercial benefits include improved competitive opportunities for company providers.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Effective automation can be used by many government and commercial systems. Government agencies such as the Coast Guard, FBI, and Customs could use the technology developed here in surveillance systems for routine security and anti-terrorism efforts. In addition, commercial areas such as tracking satellites and traffic patterns could benefit from the work developed under this program.

REFERENCES:
1. A. George, et. al., "A Distributed Parallel Embedded System for Autonomous Sonar Arrays," Proc. High Performance Embedded Computing (HPEC) Workshop, MIT Lincoln Lab, Lexington, MA, Sept. 17-18, 1997, pp. 241-261.
2. J. Villasensor, et. al., "Configurable Computing Solutions for Automatic Target Recognition," Proceedings of the IEEE Workshop on FPGAs for Custom Computing Machines, Napa, CA, Apr. 1996, pp. 70-79.
3. USS Greeneville/Ehime Maru Collision Update, NTSB Advisory, National Transportation Safety Board, Washington, DC 20594,March 2, 2001,http://www.ntsb.gov/Pressrel/2001/010302.htm

KEYWORDS: Collision avoidance, SONAR, image processing, data fusion, system architecture, software.

N04-065 TITLE: In-Harbor/At-Sea Ship Defense

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: Naval Fires Control System (NFCS)

OBJECTIVE: Develop a system to provide autonomous surveillance of port/at-sea waters surrounding a ship out to a radius that would allow the ship sufficient time to activate defensive measures.

DESCRIPTION: Terrorists can employ small water craft, boats, submersibles and swimmers to detonate explosives along side ships, or attach devices to the hull above or below the waterline. Ship defense against "asymmetrical threat" targets such as multiple small boats in the complex littoral environment is made difficult by the limited capability of shipboard sensors to detect these targets among waves, among other traffic, and against the littoral background. Air assets have much better line of sight to detect these targets, but maintaining a LAMPS helicopter in an overwatch station continuously requires enormous resources and diverts a valuable asset from other important missions. This system will be required to operate in a real-time environment twenty-four hours a day seven days a week in all weather conditions. The system should identify approaching vessels or swimmers on the surface or submerged. This program will focus on early detection of approaching vessels or swimmers to preclude damage to naval vessels. Sensors/systems employed to counter this threat will have minimal impact on the environment (geologic and biologic) and will not alter or inhibit standard in-port routines such as taking on fuel, stores or personnel, or normal peacetime underway steaming. Innovative concepts for the sensor/craft and its launch/recovery system that reduce maintenance or limit the operational impact upon the Navy Combatant deploying this vehicle are of particular interest. Upon detecting a possible threat the system shall automatically alert ship's personnel. It should localize the threat and support net centric defense operations.

PHASE I: Develop a concept with a well designed system to best meet the multiple types of threats. Define the sensor and system requirements needed for the design approach. Provide modeling which demonstrates the design concept while using sensors, systems and algorithms planned for use during the development. Provide estimates of probability of detection (POD) and false alarm rates (FAR) based on the design while considering varying harbor/water environments during high, medium and low periods of shipping traffic. Simulate its performance in shipboard operations including launch and recovery in a variety of weather and sea conditions; and characterize its endurance as dependant on payload weight and power requirements.

PHASE II: Construct and demonstrate a prototype "In-Harbor Ship Defense" and/or "At Sea Ship Defense" system to effectively detect approaching vessels and swimmers. Demonstration will be conducted in two phases: laboratory and in-situ aboard ship platforms in varying environments.

PHASE III: Transition the technology (hardware/training/ procedures/etc.) to the U.S. Navy infrastructure. Integrate full capability into U.S. Naval surface ship platforms to protect against terrorist attacks/asymmetric threat. Transition the system to military and commercial industry.

PRIVATE SECTOR COMMERCIAL POTENTIAL: In-harbor/at sea ship defense systems developed from this SBIR could potentially benefit both commercial (freighters/tankers) and military ships in high risk environments. This system may also be applied to other Homeland Defense requirements.

REFERENCES:
1. Department of Defense (DoD), USS Cole (DDG 67) Commission Report, 2001
2. Incident Report of Terrorist Attack on French Oil Tanker,2002
3. MARINE SAFETY ADVISORY NO. 28-02, Heightened Terrorism Threat to Vessels, Shore-Side Facilities and Transportation Infrastructure, 12 November 2002

KEYWORDS: Geologic; Biologic; Sensors; Net Centric; Modeling; Harbor; Autonomous; Defense

N04-066 TITLE: Submarine Tactical Control Mission Planning

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: AN/BYG-1 Tactical Control System program

OBJECTIVE: Develop an insitu, interactive, and dynamic tactics planning and evaluation systems. This supports mission planning in the submarine operational environment utilizing modern tactical control systems. Develop tools to plan submarine missions and visualize cause/effect relationships of tactical plan versus the evolving organic situation.

DESCRIPTION: Current operational practices onboard U.S. Naval Submarines requires that mission planning be conducted well in advance of entering an assigned operational area. This planning is primarily conducted manually due to the limited automation available to the operators. Once the submarine enters the operational area, the plan must be continually updated and re-evaluated. Currently, evaluation can only be partially accomplished utilizing manual techniques and relies heavily on the expertise of the operator. No methods exist to automate this process to provide visualization of the cause/effect relationships that the plan has with respect to the continually changing tactical scene.

To better support the planning process, an embedded system must be created that facilitates creating, editing and visualizing a tactical plan of action for the ship. This system must account for battlespace uncertainty and must accommodate all aspects of a mission plan, including ship positioning, weapon and countermeasure employment, evasion and overall ship tactical posture. Once the plan is created, a mechanism for evaluating it against known uncertainties must be provided.

Evaluation is the principle output of the planning process. The decision-maker must be afforded an opportunity to see the effects of the created plan. This visualization can be played into the future with tactical uncertainty clearly depicted. While conducting this visualization-based evaluation, the decision-maker should have the option to discriminate between worst-case, average and best-case reactions by other entities present in the tactical scene. These cases must be defined through uncertainty modeling techniques with patterns defined by operational experience.

Reference 1 is a paper written on Mission Planning in 1998, and forms the technical basis for this topic. This paper presents a graphical approach to plan the execution of interdependent tasks in a complex environment. Task Planning requires the assignment of a set of assets to each task within a specified opportunity window. Each task has a geographic location and requires the movement of assets prior to processing. Each asset has multiple attributes. Assets are generally combined to meet the attribute requirements of a given task. The graphical model consists of nodes, denoting tasks, and edges, representing relationships among tasks. These tasks and relationships must be extracted from the mission to accurately model the temporal and geographic requirements of the assets as well as the procedural aspects of the mission. The simplicity of the dependency graph and the underlying data structures allow task planning to be accomplished via "off-the-shelf" algorithms. A plan is determined by sequentially assigning assets to tasks using a greedy heuristic. Each assignment corresponds to a subproblem, where a set of assets is selected to process a single task. The performance of this heuristic is improved via a rollout algorithm.

PHASE I: Assess feasibility of creating mission planning system, play-ahead visualization and entity operational modeling. Describe the development approach to be taken to create software applications to build the system, visualization tools and the data gathering required for entity modeling.

PHASE II: Develop prototype submarine mission planning system as described in Phase I.

PHASE III: Fully develop, integrate and test submarine mission planning system in conjunction with current submarine information management/tactical control systems. Commercial benefits include improved competitive opportunities for more providers.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Robust mission planning systems have applicability in any industrial application where entities move in a partially predictable manner and where clear objectives exist for a single entity. The ability to visualize the effects of a plan is not typically provided in any case where industry requires a plan for movement or employment of any entity. The solution to this submarine-unique problem would provide benefit in these related areas.

REFERENCES:
1. Michael L. Curry, David L. Kleinman, Krishna R. Pattipati. “On Mission Planning: A Foundation for Organizational Design.” 1998. http://www.dodccrp.org/Proceedings/DOCS/wcd00000/wcd0009f.htm

KEYWORDS: Combat Control, Tactical Control, Mission Planning, Battlespace Visualization, Submarine, Human System Interface

N04-067 TITLE: Syntax Independent Models in XML for Software Structure Analysis.

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: SHIP SELF DEFENSE SYSTEM (SSDS) MK1 AND MK2

OBJECTIVE: Develop a syntax independent software model tool in XML such that legacy software capabilities could be accurately represented and analyzed to support system upgrade, reverse engineering, reuse and/or analysis of system capabilities evolution.

DESCRIPTION: Legacy software systems persist in the Navy systems arena as standardization efforts such as Open Architecture (OA) attempt to upgrade existing software systems. Millions of dollars are being spent upgrading legacy Navy systems to new platforms, porting software to new programming languages, and creating high-level models. Many systems are so large that testing and analysis of problems are rarely performed adequately. For example, features of an original system may be easily left out of ad-hoc requirements analysis resulting in a new system that may not perform all the necessary functions of the older system. These missing features are often not discovered until the system is deployed.

One way to ensure a new system performs all the functions and provides all the features of the original is through Software Translation. However, automated software translations are often cumbersome and difficult to read and may not take advantage of the best features of the target programming language. Manual software translation may take advantage of the new language features; but is time consuming, expensive, and requires a programmer with experience in both languages to facilitate this process.

Another software development paradigm to upgrade existing systems uses modeling languages such as the Unified Modeling Language (UML). UML has become a popular method of developing software due to the number of software suites that support this method and the visual nature of system development. However, even if these tools support the obsolete programming language, the result of the reverse engineering process applied to the legacy source code may be insufficient since many of the diagrams that provide great insight into a system are not generated. Therefore, the use of the UML is currently still prohibitive and expensive for legacy system rejuvenation.

The principles of software development, by contrast, have not changed significantly in the last twenty years. Software is primarily concerned with the manipulation, acquisition, and disposal of bytes of data. It should be possible, therefore to represent any software system's processes and algorithms in a way that is not biased towards one particular programming paradigm or language. The syntax independent representation of a software system has many possible applications including software translation, software structure analysis, white box testing, and change identification.

PHASE I: Develop a methodology to support XML representation of software in a syntax independent manner. Demonstrate a feasible automated capability to capture legacy source code like C++ and Ada in a syntax independent structure format such that some rudimentary metric analysis could be performed on the captured structure.

PHASE II: Develop a full-scale graphical interface prototype of the automated capability for syntax independent software representation that is capable of capture, analyze, and export software code models across various programming language.

PHASE III: Develop a commercial/military integrated development environment based on syntax independent structure for software development and reverse engineering.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability system could be applied to any software development project that is depending on or influence by its legacy code.

REFERENCES:

1. The Unified Modeling Language Reference Manual, James Rumbaugh, Ivar Jacobson and Grady Booch,Addison-Wesley, 1999
2. Navy Enterprise Application Guide v1.11 (NEADG)(http://www.tfw.navy.mil/)
3. Department of the Navy (DON) XML Work Group's XML Developer's Guide

KEYWORDS: Automation; XML; Syntax Independent Modeling; Software Structure Analysis; Software Metrics Collection; Reverse Engineering

N04-068 TITLE: Communication Analysis System for Intrusion Detection Systems (IDSs)

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT II: Aegis

OBJECTIVE: Develop an innovative engineering method to characterize the nature of the communications between distributed processors in a real-time environment in order to support the deployment of an anomaly-based intrusion detection system.

DESCRIPTION: IDSs have a strong presence in the commercial marketplace; however, there are areas of deficiency that need to be addressed before an IDS is deployed in the surface navy and AEGIS Combat System (ACS). The R&D community, as well as some commercial companies, is developing IDSs that use anomaly-based analysis in order to detect attacks. Currently, most anomaly-based IDSs have a high rate of "false-positive" detections (i.e., the IDS incorrectly declares that an attack has occurred). Many false-positive declarations occur because "normal" behavior has not been sufficiently characterized.

PHASE I: Determine the feasibility and develop a system design for a Communication Analysis System that is capable of characterizing the complex communication interactions between distributed processors in a real-time environment in order to support an anomaly-based IDS.

PHASE II: Develop and test the Communication Analysis System in an actual and/or simulated real-time, distributed environment in which the "normal" behavior is verifiable. Demonstrate the use of the suite of tools developed to support and perform the analysis.

PHASE III: Demonstrate the utility of the Communication Analysis System, including the developed toolset, in an actual real-time, distributed computing environment in order to characterize "normal" communication behavior. Integrate the Communication Analysis System with a commercially available anomaly-based IDS.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system would enable an anomaly-based IDS to be deployed effectively in any distributed computing environment. It would help to define the "normal" behavior of a complex communications system, which is a current challenge in deploying an IDS. Additionally, this system would be useful in non-IDS related tasks, such as network behavior characterization and security vulnerability assessments.

REFERENCES:
1. http://www.nwfusion.com/columnists/2002/0408snyder.html
2. Stefan Axelsson, Intrusion Detection Systems: A Survey and Taxonomy, Technical report, Computer Engr Dept, Chalmers Univ of Technology, Goteborg, Sweden, 2000
3. Lawrence R. Halme and R. Kenneth Bauer. AINT misbehaving - a taxonomy of anti-intrusion techniques. In Proceedings of the 18th National Information Systems Security Conference, pages 163-172, October 1995

KEYWORDS: Information assurance; intrusion detection system; communication characterization; networks; real-time; distributed computing

N04-069 TITLE: <u>Analytical tool sets with models, metrics, and measurement techniques for System Architecture development.</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT 1 – DD(X)

OBJECTIVE: Development of an innovative modeling and simulation approach with a supporting tool set which enables system and software engineers to analyze architectures and designs with respect to their quality attributes and quality attribute trade-offs, inter-dependencies, sensitivity points, and risks.

DESCRIPTION: Complex mission critical system development requires thorough and accurate architectural analysis, especially with respect to the complex interactions between competing system quality attributes and requirements that the system must meet. Failure to use an effective architecture is a characteristic of unsuccessful, software-intensive projects.

The current state of technology in the development of mission-critical systems relies on multiple, separated, dedicated domains (as many as ten to twenty) each with a number of components (on the order of hundreds). These domains and components have a fixed, hard allocation of processes to processors (both in the software-to-hardware sense and the tactical task-to-assigned operator sense). This type of system design and development features a rigid assignment of functionality to supporting computers and people as well as implementing protection against single point failures through a pre-planned, limited static allocation of redundant resources. This pre-planned, limited, static allocation can be thoroughly analyzed and tested in all of the possible configurations. This fixed static allocation supports relatively easy module dependency determination and affordable system test and certification, but limits overall system flexibility and survivability.

Modern systems, seeking to optimize reliability, availability, and affordability, are characterized by widely distributed, dynamically reconfigured system architectures relying on new COTS technology. The level of complexity in these new systems approaches tens of thousands of components allocated to thousands of execution hosts, which are dynamically reconfiguring into variable, unpredictable configurations at sub-second periodicity. While these new, distributed, dynamically reconfigurable systems provide significant benefits in warfighting capability, availability, and total ownership costs, they present distinct obstacles in the ability to generate and assess the validity of complex system architectures.

An innovative approach is needed to develop a toolset and associated metrics and measurement techniques to assist engineers with the architectural modeling and analysis to be able to validly reason about the suitability and correctness of the system architecture. Included with the tool set are analysis concepts, critical performance parameter definitions, and measurement techniques for collecting meaningful metrics. The tool set shall focus on analyzing architectural trade-offs, sensitivity points and risks.

PHASE I: Demonstrate the feasibility of an innovative toolset to address the assessment of a complex system architecture. The proposed concept should define a representative, highly distributed dynamically configured architecture and select, design, or create a toolset and associated measurement techniques to analyze that architecture. The concept should propose a set of stimulus test cases to exercise the architecture assessment approach and the supporting tool suite. The concept should also propose a set of potential metrics to be collected.

PHASE II: Fabricate and demonstrate the prototype tool set in accordance with the stimulus test cases using the proposed metrics developed in Phase I. Review, with the Navy, the results of the test, and revise the approach, the metrics and the tool suite as appropriate.

PHASE III: Finalize and validate the assessment approach by way of application to an existing Navy selected sub-system to determine if performance predictions match experienced reality. Working with the Navy, develop user-friendly packages for use by engineering firms in civilian and military domains. Specifically work with the DD(X) Design Agent to apply the validated approach and the support products to the full DD(X) Total Ship System.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This tool set could be particularly effective in support system architecture and design issues for large commercial network based applications. Some specific applications could be 1) web based education environments where the sharing of training modules across a broad spectrum of users is necessary as well as 2) addressing the design issues surrounding the interfacing of service modules within future homes i.e. entertainment systems, utility systems and communication systems, etc.

REFERENCES:
1. www.viking.gmu.edu - regarding executable models for architectures – Illustrative of the technology recognition of need for architecture modeling, this series of discussions emphasizes the importance of an early ability to accurately define and analyze architectures though the use of executable models. Some limited concepts are introduced and the lack of a cohesive approach and a structured method are discussed.
2. The OMG (www.omg.org/) and the Systems and Software Architecture Laboratory at Purdue. - These references provide illustrative information regarding modeling approaches and the problem of accurately capturing and modeling the interaction between distributed objects (primarily software) and their behavior in a total systems execution context.
3. www.informatik.uni-hamburg and SRI International System Design Laboratory. These references discuss issues regarding distributed system analysis techniques, possible concepts for instrumentation, measurement, and analysis of traditionally unpredictable distributed systems behavior.

KEYWORDS: Analysis, Modeling, Architecture, Metrics, Measurement

N04-070 TITLE: Compact Variable Depth Sonar (CVDS)

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT 1 – DD(X)

OBJECTIVE: Develop and test critical elements enabling the design of a compact, high-power, broadband, variable depth active acoustic source that significantly minimizes ship impact with respect to the VDS size, weight, handling and manning requirements.

DESCRIPTION: Recent sea tests with a Variable Depth Source (VDS) (e.g. IUSW-21, LBVDS) have demonstrated increased submarine detection capabilities with a broadband active source that provide continuous active acoustic coverage below the layer and along the entire water column. The primary disadvantage of a VDS is the high impact that its launch and recovery system has on ship design. Successful demonstration of key risk areas including automated launch and recovery and tow body design that leads to a small volume, lightweight system deployable from a small onboard handling system is desired. The system proposed should address source levels greater than 200dB//1 uPa at 1 meter and should span a frequency range of 1-7 kHz. It should be modular, able to fit inside a 30 foot ISO container (30 x 8 x 8.5 feet) to allow for installation on a variety of smaller future vessels or possibly unmanned vehicles. It may also be required to search the water column rapidly, therefore deployment and retrieval speeds will be a consideration.

PHASE I: Develop a conceptual design of a compact active variable-depth broadband source and perform static acoustic performance modeling for source level, transmit beam coverage, and transmit energy requirements. Define a concept for the associated handling gear.

PHASE II: Develop a detailed prototype design of the array, array housing, and transmit electronics. Fabricate the critical components of the prototype system and conduct small scale testing to demonstrate the durability of the components under simulated launch and recovery conditions.

PHASE III: Design and fabricate a prototype handling system for the VDS. Install and test system on a research vessel or Navy ship with a towed receiver to demonstrate detection capabilities, compactness, and ship impact.

PRIVATE SECTOR COMMERCIAL POTENTIAL: In addition to Navy uses, it also has potential applications in the oil exploration industry and the launch and recovery system has direct transition potential to the oceanography industry.

REFERENCES:
1. Chief of Naval Operations, “Non-Acqusition Program Definition Document for Lightweight Broadband Variable Depth Sonar,” NAPDD #384-865, Washington, DC, 18 December 1996.
2. Simard, M. E., “Lightweight Broadband Variable Depth Sonar (LBVDS) Program Executive Summary,” NUWC-NPT Technical Memo 02-102, Naval Undersea Warfare Center Division, Newport, RI, 1 August 2002.
3. Fridge, H. E., “Performance Expectation For AN/SQS-23 & AN/SQS-35 SONARs Installed In CVA/CVS Type Ships ” Navy Underwater Sound Laboratory, New London CT, 15 March 1966.

KEYWORDS: variable depth active sonar, VDS, broadband, low ship impact, transmit beamwidth, handling gear

N04-071 TITLE: Surface Ship, Hull Mounted, Mine Avoidance Sonar

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT 1 – DD(X)

OBJECTIVE: Develop a prototype system, device, and/or technique to reduce the impact of surface effects and the near-field physical environment on the detection and classification performance of a bow mounted high or medium frequency surface ship mine avoidance sonar.

DESCRIPTION: Ship motion, ship speed, reverberation, surface acoustic interactions, bubble fields, organic matter, and other phenomena in the near-field physical ocean environment impact the performance of high frequency sonar systems. These effects, significantly impact the ability of operators to detect and classify mines and mine-like objects in a littoral ocean environment. Algorithms designed to automatically detect and classify mine-like objects are also subject to high false alarm rates and low operator confidence. As our understanding of the physical processes continues to grow, new methods of characterizing this complex acoustic environment are being sought. Innovative improvements in modeling, algorithms, signal processing techniques, and/or parametric transmissions and processing are required to improve and enhance acoustic sonar systems so that mines and mine like objects can effectively be neutralized or avoided by Naval ships.

PHASE I: Demonstrate the feasibility of developing improved detection and classification capabilities. Assess signal processing algorithms and techniques that improve detection and classification of mines and mine-like objects. Define a proposed concept and provide a preliminary design of a prototype system or device.

PHASE II: Finalize the prototype design. Fabricate the critical components of the prototype system and conduct laboratory characterization experiments. Provide a detailed test plan and conduct a scaled capabilities demonstration of the prototype.

PHASE III: Working with Navy and Industry partners, build a full-scale prototype to be tested in a naval shipboard environment. Interface the prototype with the DD(X) HF Mine Avoidance Bow Sonar. Develop a test plan, install, and demonstrate the commercial and naval capabilities of the system. Develop a plan to transition the system or device to production.

PRIVATE SECTOR COMMERCIAL POTENTIAL: In addition to Navy uses, this system, device, and/or technique could be used to improve collision-warning capabilities for high-speed vessels such as tankers, cargo carriers, and passenger ferries.

REFERENCES:
1. F. B. Shin and D.H. Kil, "Robust Mine Detection and Classification with target Physics-Derived Features and Classifiers," Proceedings of the IEEE International Conference on Oceans 1996, Fort Lauderdale, FL, September 1996.
2. W. L. J. Fox and A. Maguer, "Experimental Results for Detection of Buried Objects at Low Grazing Angles". J. Acoust. Soc. Am. 104(3), 1784, 1998.
3. S. W. Wolffe, "Parametric Sonar Non-Linear Acoustics and Finite Amplitude Acoustics: An Annotated Bibliography". Report Number NUSC-LA13-C40-75, 1975.
4. L. F. Carlton, "Parametric Source Performance with Various Drive Waveforms". NUSC Technical Memorandum 77-1155, 1977.

KEYWORDS: HF; sonar; mine avoidance; small object avoidance; parametric; projector; receiver; detection

N04-072 TITLE: <u>Exploitable Features for Target Classification in High Frequency Mine Avoidance Sonars</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT 1 – DD(X)

OBJECTIVE: Development of a prototype system that applies the technology of HF side scan imaging used in mine reconnaissance to support higher resolution imaging of HF hull mounted sonars. This higher resolution will result in a reduction in false contacts.

DESCRIPTION: High frequency side scan imaging sonars used in mine reconnaissance provide images that contain a multitude of exploitable target features, such as echo and shadow characteristics. Conversely, hull-mounted high frequency forward-looking sonars employ acoustic beams that do not support high-resolution imaging, resulting in significantly fewer available features for mine-like target classification. Algorithms that derive exploitable features from the temporal, spectral, and/or spatial characteristics of echoes from mine-like targets can be used to improve hull-mounted sonar performance. These features should be proven, through testing on in-situ data, to provide discrimination against naturally occurring objects that are typically found on the seafloor (e.g., rocks). Integration of such algorithms and features into existing Computer Aided Detection / Computer Aided Classification (CAD/CAC) algorithms for mine avoidance would benefit future ships development by lowering the mine avoidance false alert rates.

PHASE I: Demonstrate feasibility of adapting specific exploitation features for target classification into hull mounted sonar systems. Provide a preliminary design concept for evaluation and selection.

PHASE II: Develop prototype based on the design concept selected from Phase I. Provide a detailed test plan, finalize and conduct a scaled capabilities demonstration of the prototype.

PHASE III: Implementation and integration into an existing hull mounted CAD/CAC as a part of the DD(X) IUSW high frequency in-stride Mine Avoidance sonar system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology could be adapted for use and improvement of commercial vessels object avoidance systems.

REFERENCES:

1. M. H. Supriya and P. R. Saseendran Pillai, " Development of an Underwater Target Classifier Using Target Specific Features," The Journal of the Acoustical Society of America, Vol. 113, Issue 4, April 2003.
2. John R. Sacha, "Automatic Target Recognition in Acoustics: An Overview," The Journal of the Acoustical Society of America, Vol. 112, Issue 5, November 2002.
3. F. B. Shin and D.H. Kil, "Robust Mine Detection and Classification with target Physics-Derived Features and Classifiers," Proceedings of the IEEE International Conference on Oceans 1996, Fort Lauderdale, FL, September 1996.
4. A. Truccom, "Detection of Objects Buried in the Seafloor by a Pattern-Recognition Approach," IEEE Journal of Ocean Engineering, vol. 26, no. 4, October 2001.

KEYWORDS: sonar; side-scan; feature; recognition; CAD/CAC; mine avoidance

N04-073 TITLE: <u>Bulkhead Shaft Sealing Device for Damage Control</u>

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IC; PMS 400D; DDG 51

OBJECTIVE: Development of a bulkhead shaft sealing device that can be deployed either automatically or manually to prevent excessive flooding in a casualty situation.

DESCRIPTION: When damaged, as a result of explosion or collision, bulkhead shaft seals can leak and cause sufficient flooding to jeopardize the ship. An innovative concept or device is sought that can be deployed manually to limit flooding through the shaft seal in a casualty situation to approximately 0.5 gpm. When deployed the device should not further damage the shaft or prevent its operation. The device should be capable of being installed by no more than two crew members in 10 minutes or less. Alternatively, the device could be permanently mounted in a manner not to interfere with normal shaft operations and manually or automatically deployed in response to a casualty.

PHASE I: Demonstrate the feasibility of the concept for preventing excessive leakage through the bulkhead shaft seals in the event of a casualty. Define the proposed concept and develop key component and technological milestones.

PHASE II: Finalize the design; fabricate and validate a prototype system. Conduct life-cycle testing and demonstrate operation of the prototype. Develop a plan for a practical implementation of the validated prototype system.

PHASE III: Working with the Navy and commercial industry, develop a full-scale system for testing and installation on a naval vessel.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This product would be applicable to the commercial shipbuilding industry as well as large industrial applications, such as hydroelectric plants, where damage to turbine systems could result in flooding.

REFERENCES:
1. DDG 51 Class Bulkhead Shaft Seal Technical Manual, S9243A8MMA010

KEYWORDS: Shaft Seal; Leakage; Flooding; Damage Control; Bulkheads

N04-074 TITLE: Advanced Deck Covering Materials

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IC; DDG 51; PMS 400D

OBJECTIVE: Develop an advanced deck covering or coating for application to naval interior decks that that will reduce deck brittle fragmentation in the event of an explosive casualty and that is also, resilient, lightweight, durable, and easy to install and maintain.

DESCRIPTION: In the event of an explosive casualty, existing interior decking can fail brittle with the fragments becoming “missile hazards” for the crew and the ship systems. Additionally, existing interior decking requires extensive labor for routine scrubbing, waxing and buffing. An innovative decking covering or coating is desired that reduces hazards and maintenance. The covering or coating should also meet shipboard fire, smoke, and toxicity requirements and be both lightweight and easy to apply and repair. The coating should have good adhesion to the steel deck substrate in high humidity, wear and tear environments, and should have a rapid cure/dry time for installation. The coating must also meet the Navy’s requirement for oil and slip resistance.

PHASE I: Demonstrate the feasibility of a deck covering or coating material to meet the hazard, maintenance, and shipboard requirements described. Conduct limited testing, as needed, to support demonstration of feasibility and recommendations. Develop a plan to demonstrate the application procedures and life-cycle performance of the recommended covering or coating.

PHASE II: Finalize the covering or coating design and fabricate and install a prototype coating on representative decking test articles. Conduct laboratory testing to validate installation methods, environmental characteristics, and maintenance and use. Develop and demonstrate methods to repair a coated deck. Develop a plan for installation, performance evaluation, life-cycle monitoring, and repair on board a naval vessel.

PHASE III: Working with the Navy and commercial industry, install a deck covering or coating on a naval vessel. Evaluate its performance over its life-cycle. Demonstrate methods to repair the deck using ship’s crew. Provide training to ship’s crew on installation, maintenance, and repair procedures.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This product is applicable to industrial manufacturing or process environments were there is a danger of explosion from high pressure piping, gas containments, or other sources and a lightweight, resilient, low maintenance, durable flooring surface is desired.

REFERENCES:
1. U. Sorathia, G. Long, M. Blum, J. Ness, T. Gracik; “Performance Requirements for Fire Safety of Materials in U.S. Navy Ships and Submarines”, Proceedings of 46th International SAMPE Symposium and Exhibition, Volume 46, Book 2, May 2001.
2. “Deck Covering Materials”, MIL-D-3134J

KEYWORDS: Decking; maintenance free; resurfacing; quality of life; flooring

N04-075 TITLE: Electromagnetic Pulse Protection For Distributed, Shipboard Transducer-bus Networks

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT IV, Smartship

OBJECTIVE: Develop and demonstrate a distributed, shipboard transducer-bus network that is capable of withstanding high levels of EMP (electromagnetic pulse).

DESCRIPTION: Electromagnetic Pulse (EMP) has long been recognized as a threat to electronic systems, including military systems. An EMP can have so much energy that it is highly dangerous to sensitive electronic equipment, including but not limited to semiconductor devices (e.g. computer chips). EMP bursts caused by hostile devices may last from only a few nanoseconds to as long as several milliseconds and induce transient voltages of thousands of volts on exposed electrical conductors such as copper wires or conductive tracks on printed circuit boards. The U.S. Naval vessel of the future is envisioned to be a highly automated vessel requiring many transducers (sensors and actuators) with networks/data buses to connect them. These data buses will be mission critical systems that need to be protected from harmful environmental effects. While certain physical and electrical designs can successfully mitigate the effects of EMP pulses of various strengths, protecting against them is quite expensive for each chip. As a result, few electronic devices in commercial use would survive a large EMP.

Semiconductor-based devices are very sensitive to exposure to high voltage transients. What is significant about semiconductor-based devices is that very little energy is required to permanently damage or destroy them. Any voltage typically in excess of tens of volts can produce an effect termed “gate junction breakdown” that effectively destroys the device. Damaged devices may still function but their reliability will be seriously impaired. Shielding electronics by equipment chassis provides only limited protection, as any cables running in and out of the equipment will behave very much like an antenna, in effect guiding the high voltage transients into the equipment. This is very pertinent to the technology of transducer-bus networks as they may consist of thousands of meters of electrical cabling running throughout the ship.

As ships get increasingly automated, resulting in a significant increase in transducers and supporting networks, an EMP attack could severely hamper or even cripple operations. An EMP survivable transducer data-bus is needed for future Naval vessels. The system developed should be as compatible as possible with open architectures and investigators should consider compatibility with existing or developing transducer-bus standards such as the IEEE 1451 family of standards.

PHASE I: Demonstrate the feasibility of the proposed concept of a transducer data bus that is able to survive the large powers and energies associated with an EMP. In conducting this assessment, the small business should review information that has been done on EMP effects on military and commercial electronics and data networks. While developing a preliminary design existing and developing commercial and military standards and practices related to transducer busses should be taken into account.

PHASE II: Build prototype transducer data bus and conduct limited testing in a laboratory environment. The prototype bus would not need to be tested to withstand high-level EMP, but must demonstrate basic pulse-resistance under normal operating conditions. Perform analysis of system performance under high-level EMP condition.

PHASE III: Working with the Navy, finalize the EMP survivable transducer data bus design. Develop a full-scale system and demonstrate resistance to high-level electromagnetic pulses. This task will require sophisticated testing equipment and will most likely require use of an appropriate EMP test facility. Develop a manufacturing and commercialization plan including purchase, installation and life cycle cost estimates.

PRIVATE SECTOR COMMERCIALIZATION POTENTIAL: Future generations of commercial airplanes and ships will have transducer-bus control, monitoring and automation networks. Civilian as well as military computer systems can be affected by EMP damage. The effects of EMP damage are potentially great for these systems as well. Given the ease with which EMP threats can be developed, both commercial and military markets will be available.

REFERENCES:

Definition and use of EMP

1. http://www.its.bldrdoc.gov/fs-1037/dir-013/_1938.htm
2. http://www.physics.northwestern.edu/classes/2001Fall/Phyx135-2/19/emp.htm
3. http://www.airpower.maxwell.af.mil/airchronicles/kopp/apjemp.html
4. http://www.geocities.com/CapeCanaveral/5971/emp.html
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6. http://www.fas.org/spp/starwars/congress/1997_h/h970716u.htm
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8. http://commdocs.house.gov/committees/security/has280010.000/has280010_0f.htm

KEYWORDS: Transducer-bus network, sensor, actuator, transducer, electromagnetic pulse, semiconductor, nuclear bomb, transient voltage

N04-076 TITLE: Wireless LAN Emissions Attenuation Technologies

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT IV, Smartship

OBJECTIVE: Develop and demonstrate technologies capable of allowing strong RF signals in a localized area while preventing propagation of those signals to a distance. The systems should allow use of commercial, standardized wireless LAN protocols and equipment to the maximum extent possible.

DESCRIPTION: The U.S. Naval vessel of the future is envisioned to require a much lower level of manning than current vessels, requiring significant levels of automation. High levels of automation increase the demand on data/information access and transfer. Wireless networks and systems provide a cost effective mechanism to enable this increased level of data/information transfer and are expected to become more prevalent on ships of the future. Wireless technology presents significant challenges in the area of security and detectability due to the RF emissions from these systems that can propagate for long distances. This is of particular concern with U.S. Navy vessels due to the high security demands and the need to operate in Emissions Controlled (EMCON) conditions. RF signals have the capability of moving beyond the confines of the vessel, thereby enabling outside entities the possibility of intercepting those signals with the goal of detecting a ship's presence or exploiting the signal to collect information.

This topic seeks to develop technologies or approaches that will allow RF communications technology to be utilized in a localized area, while preventing the generated RF signals from propagating at significant strength at a distance. The goal is to have a fairly sharp boundary condition between the local and non-local environment such that RF power levels are high in the local area but drop sharply, over a short boundary distance, when moving to the non-local environment. The exact distance of the virtual boundary could vary but must meet EMCON requirements at a minimum. EMCON requirements state that RF signals must not exceed –110 dBm/m2 at one nautical mile. An 802.11b device, operating at 1 watt (the maximum power allowed under IEEE 802.11b) would have a power density of approximately –46 dBm/m2 at one nautical mile. Hence, WLAN technology developed should be able to attenuate the WLAN signal such that an attenuation of at least 64 dB at one nautical mile is obtained.

Approaches to developing this capability might utilize components external to the RF communications system to create a boundary in some manner or they might be inherent to the RF communications system, creating a signal that inherently has the desired characteristics. The initial focus of the effort should address current popular RF wireless technologies such as IEEE 802.11b/WiFi systems and other 802.11 family protocols. However, the most desirable solutions will be broadly applicable to a variety of possible RF communication mechanisms. Solutions that take an open systems approach and are compatible with existing standards are most desirable.

PHASE I: Perform an analysis/study of the problem and develop a requirements document defining the problem. Develop a conceptual design for a wireless LAN emissions attenuation system.

PHASE II: Develop a detailed design and prototype. Perform laboratory tests demonstrating system.

PHASE III: Finalize design, build a final-version system and demonstrate in a shipboard environment.

PRIVATE SECTOR COMMERCIALIZATION POTENTIAL: Wireless technology is proliferating rapidly in the commercial sector and the market will grow in the military sector as well. Given the concerns related to security of wireless systems, technologies that address security concerns should have high market potential.

REFERENCES:
Information on industry WLAN standards:
1. http://grouper.ieee.org/groups/802/11/
2. ANSI/IEEE Standard 802.11, 1999 Edition
3. IEEE Std 802.11b-1999
4. IEEE Std 802.15.1-2002
Information on DoD wireless requirements:
5. Draft DoD Directive 8100.bb: Use of Commercial Wireless Devices, Services and Technologies in the DoD Global Information Grid
6. MIL-STD-464, Electromagnetic Environmental Effects Requirements for Systems
Information on WLAN risks
7. EETIMES, 6 August, 2001. Cipher attack delivers heavy blow to WLAN security. Website: http://www.eetimes.com/story/OEG20010806S000
8. University Maryland, March 2001, Your 802.11 Wireless Network has No Clothes. Website: http://www.cs.umd.edu/~waa/wireless.pdf

KEYWORDS: Wireless network, network, RF, communications, security

N04-077 TITLE: Automated Highline/ Spanwire Engagement

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT 1 – DD(X)

OBJECTIVE: An automated rigging method shall be provided to enable the current Standard Tension Replenishment Alongside Method (STREAM) wire rope rig to be received and engaged with a maximum of three personnel on deck.

DESCRIPTION: Legacy Underway Replenishment is a manpower intensive operation requiring between 10 and 30 personnel depending upon ship type. Small ships rely on 25 seamen to pull the highline or spanwire across from the delivery ship, manually cut lashings and 2 – 3 people are required to wrestle the wire rope to its mechanical connection on the fuel receiver or cargo kingpost. Often, these operations are conducted in sea state 5 with significant ship motion on smaller combatant receiving stations.

With the manning reductions that are anticipated in the design of future ships, innovative approaches are necessary to address the development of a rigging alternative that will permit the removal of excess line handlers during a replenishment evolution. The concept proposed will need to address the efficient powering of a spanwire between the delivery and receiving ships and automatic engagement of the spanwire to the receiver.

The concept proposed will need to advance rigging operations to be more autonomous. Expected technology advancement includes sensors, and advanced wire rope devices capable of near autonomous engagement operations.

PHASE I: Demonstrate the feasibility of the proposed design concept to enable the automated receipt and engagement of a STREAM fuel rig. Develop a preliminary design and conduct analysis to support feasibility of the proposed concept. The proposer shall specify projected performance design requirements and identify projected integration issues with respect to the implementation of reduced manning during the spanwire hauling evolution. Also, the proposer shall address the adaptability of the proposed engagement device for use on a solid cargo highline STREAM receiving station.

PHASE II: Develop a prototype fuel receiver with automated spanwire engagement to include development of a prototype receiver swivel arm. Working with the Navy, demonstrate the fuel rigging procedures within the operational range of the swivel arm movement with simulated spanwire load conditions at sea.

PHASE III: Working with the Navy and Industry, install at sea and demonstrate in a fueling evolution. The Navy shall provide host platform to demonstrate effectiveness. Since all single probe fuel receiver stations are of standard design, any active platform with single probe receiver capability is acceptable.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial oil tankers could use this technology to automatically connect and thereby expedite the offloading of fuel stores to offshore pipe heads. Automated engagement devices can improve transfer of liquid and solid cargo to lighters with personnel safety enhancement. Commercial applications of the technology for an automated connection for a wire rope could include yachting halyards, ship towing, commercial boat davits and remote vehicle recovery.

REFERENCES:

1. NAVSEA S9AAO-AA-SPN-010 General Specifications for Ships of the US Navy
2. NWP 4-01.4 Underway Replenishment
3. BUSHIPS 805-2213794 Single Probe Fueling Arrg't
4. MIL-STD-167-1 Mechanical Vibrations of Shipboard Equipment
5. MIL-STD-882 Standard Practice for System Safety
6. MIL-S-901 Shock Tests, High Impact Shipboard Machinery, Equipment and Systems, Requirements
7. DOD-STD-1399 Interface Standard for Shipboard Systems
8. OPNAV 5100.19 Navy Occupational Safety and Health

KEYWORDS: Fuel receiver; automated connection; receiver; UNREP

N04-078 TITLE: UAV based Network-Centric Communications for Sensors

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT 1 – LCS

OBJECTIVE: Analyze, evaluate, develop and demonstrate a UAV based communications relay for sensor and mobile sensor data to surface combatants as well as command and control (C2) between the surface combatant and deployed sensors, autonomous vehicles and manned vehicles.

DESCRIPTION: The military has been developing deployable and mobile sensors that can be used to perform a variety of functions. These sensors extend the sensing horizon for Naval Surface Combatants permitting fewer combatants to maintain near-real-time situational awareness of the operating environment and potential battlespace. The surface combatant needs an autonomous airborne communications relay to send data from distributed sensors on the surface or in the air back to surface combatants. These distributed sensors can be on multiple types of vehicles such as: other UAVs, surface vehicles, underwater vehicles or other distributed sensors beyond the line-of-sight of the Naval Vessel. The communications relay must be able to support simultaneous multiple channels for data from widely distributed sensors back to the surface combatant. This relay provides a similar capability as a satellite communications relay. The use of a UAV based system provides the ship with an over-the-horizon (OTH) relay that is not dependent on a Satellite link.

The desired innovation is to package small light weight (satellite like) relay system into a UAV module that can endure the environmental impact of a UAV as well as manageing multiple channel communications. Specific relay needs include: transfer of sensor data; transfer of UAV C2; and transfer of C2 for mobile autonomous sensor vehicles. Communications of sensor data may require 10's Mbytes/sec throughput. Sensors may be distributed over vast areas requiring the communications relay to communicate with multiple devices in multiple directions simultaneously. As a minimum, the communications relay would support: 3 channels expandable to 6 in KU band; 1 channel minimum in UHF Band; with a throughput of 10.7 Mbytes per channel.

PHASE I: Demonstrate the feasibility of a UAV communication relay that provides network-centric connectivity between distributed and mobile sensors and a patrolling surface combatant. Evaluate current and planned GOTS and COTS communications devices (radios, antennas, etc.) that could be operated from a surface combatant based UAV. Develop, with Navy guidance, performance characteristics of the current state of communications.

PHASE II: Finalize the design. Build and test a prototype communications relay system. Validate system performance characteristics and demonstrate over-the-horizon capability. Develop system cost estimates (both acquisition and lifecycle).

PHASE III: Conduct shipboard / UAV testing to evaluate performance in the Navy environment and develop plans for shipboard certification and application. Complete design package and system cost estimates for future acquisition.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private industry and in particular wire-less communications for cell phones, satellite phones, and data transponders will benefit from low-cost communications relays.

REFERENCES:

1. Naval UAV Overview: http://www.dtic.mil/ndia/targets/fitch.pdf
2. BAMS, Eagle Eyes, and Dragon Eyes – The services muster unmanned aerial vehicles for growing list of missions: 2003 - http://www.navyleague.org/sea_power/apr_03_66.php
3. Unmanned Aerial Vehicles (UAVs) Roadmap (2002 to 2027), December 2002, Office of Secretary Department of Defense, Released 11 March 2003
4. Roles for Unmanned Vehicles, Naval Research Advisory Committee, Presentation to Flag Offices and SES's, Pentagon 5A1070, 18 November 2002

KEYWORDS: unmanned air vehicles (UAV); communications; relay; sensors; mobile; covert

N04-079 TITLE: Control/Diagnostic/Maintenance System for High Speed, High Output Diesel Engines

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT 1 – LCS

OBJECTIVE: To develop an automated control system for marine diesel engines that controls engine operation, monitors engine performance, performs diagnostics and performs engine self-maintenance functions. This control system is intended for high speed, high output diesel engines of appropriate size for surface maritime vessels that are in the 10'–35' length range.

DESCRIPTION: The reliability and longevity of marine diesel engines for unmanned surface vehicles (USVs) will be critical factors in the USV's ability to successfully complete its mission. This is because USVs are expected to undertake extended duration missions (measured in weeks) and there will be few if any personnel aboard the host ship to perform maintenance operations on the USV. Therefore the technical challenges of improved endurance and minimum maintenance diesel engines (compared to existing marine diesel engines of similar size) need to be addressed. To achieve the goals of long endurance and minimum maintenance, a control system is required that is configurable and adaptable to all diesel engines, is capable of performing diagnostics on the engine, monitoring all engine subsystems, and acting as the intermediary between the craft's control system and the engine. Self-maintenance functions should include self-lubrication and self-cleaning filters.

PHASE I: Develop a design concept for a control system for a very low maintenance, long endurance, marinized diesel engine of 200-600 horsepower. The design concept will include engine control functions, engine performance monitoring and diagnostics, and self-maintenance systems including self-lubrication and self-cleaning filters. The goal is 1000 hours of engine operation without maintenance.

PHASE II: Develop a prototype diesel engine control system based on the design and specification developed in Phase I. Test on a marine diesel engine.

PHASE III: Install and test control system on a small surface craft. Provide detailed drawings and specifications. Anticipate transition to Small Surface Combatant program for deployment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial applications include use on any maritime vessels in the stated size range or other critical construction or industrial maintenance applications where reliability and low maintenance are important.

REFERENCES:

1. "SPARTAN Unmanned Surface Vehicle Extends the USW Battlespace-SPARTAN Concept", Naval Forces, Special Issue 2001, p. 18.
2. http://boatdesign.net/Directory/Propulsion/Engines/Diesel/ (provides examples of marine diesel engines from various manufacturers
3. http://boatbuilding.com/Propulsion/Diesel_Inboard_Engines/ (provides examples of marine diesel engines from various manufacturers

KEYWORDS: Key words: diesel engine, control system, low maintenance, long endurance

N04-080 TITLE: High Energy Density Power Sources for Unmanned Surface Vehicle (USV) Sensor Payloads

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT 1 – LCS

OBJECTIVE: To develop a high energy density electrical storage device to power sensor payloads in unmanned surface maritime vessels that are up to 35' in length and have payload capacities up to 6000 lbs. Both the sensors and their power source must fit within this 6000 lb limit.

DESCRIPTION: In the future, it is expected that the U.S. Navy will utilize unmanned surface vehicles (USVs) to perform various missions and that the mission duration may be up to two weeks. During its time on station, the USV may have its main propulsion unit shut off to reduce signature. Therefore, the USV will require an alternate high energy density power source to operate its sensor payload while on-station. This alternate power source could be, for example, battery, fuel cell, fuel cell hybrid or solar and be capable of providing a constant power level of several hundred watts up to several thousand watts, with power levels up to 25 kW for approximately 10 seconds per every minute. The power source should require minimum maintenance, both while the USV is on-station and while it is aboard its host ship. The power source must be capable of withstanding marine environments in which it will be subjected to salt spray, high humidity levels and temperature extremes. It should also have low signature. Weight, size and cost should be minimized consistent with the other requirements and compatible with a 35' long vessel having a payload of about 6000 lbs.

PHASE I: Conduct a design analysis of various candidate power systems. Evaluate energy density, power density, size, weight, anticipated maintenance requirements, ability to withstand marine environments, and signature considerations. Develop a design concept and specification for the selected power source.

PHASE II: Develop and test a prototype power source based on the design and specification developed in Phase I.

PHASE III: Install and test on a small surface craft. Provide detailed drawings and specifications. Anticipate transition to Small Surface Combatant or Sea Lion Special Operations Craft program for deployment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These power sources could be used on many types of unmanned surface vehicles supporting many maritime industrial areas including oceanographic survey vessels, off-shore oil exploration and salvage ships, shipping industry, Coast Guard and the Border Patrol. Other commercial applications include use on any maritime vessel in the stated size range as well as numerous non-maritime commercial fuel cell applications.

REFERENCES:

1. "SPARTAN Unmanned Surface Vehicle Extends the USW Battlespace-SPARTAN Concept", Naval Forces, Special Issue 2001, p. 18.

KEYWORDS: unmanned surface vehicle, fuel cell, power source, low maintenance

N04-081 TITLE: Shipboard Lighting System

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT IVT; Amphibious Warfare Program

OBJECTIVE: Develop a lighting system concept which can be both dimmed and controlled and is able to utilize the existing power structure of the ship.

DESCRIPTION: Existing shipboard power and controls systems are not able to provide the dimming and control necessary to adjust to the various lighting and atmospheric conditions experienced during at-sea aircraft operations. For this reason, the Navy seeks the development of a lighting system incorporating the use of innovative light sources that would provide a higher degree of reliability, decreased maintenance costs and NVD compatibility. The system proposed should address the timely development of form, fit and function packaging that will minimize ship impact, installation and/or integration. The system proposed should be capable of driving various light sources in series parallel configurations from the existing AC power feeds while meeting shipboard environmental requirements including shock, vibration and EMI.

PHASE I: Demonstrate the feasibility of the concept and propose a preliminary design. Develop key component technological milestones.

PHASE II: Complete module design and prototype fabrication. Perform laboratory testing to demonstrate the prototype's ability to control multiple fixtures in a typical shipboard configuration. Address the potential for shipboard replacement as well as the ability to meet shipboard environmental requirements.

PHASE III: Design and fabricate full scale system. Provisions will be made to facilitate shipboard lighting circuit testing of dimming control devices and/or entire ship's deck lighting system as deemed appropriate. Subsequent to system refinement and all first article testing, a selected circuit will be lab tested and shipboard demonstrated.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The FAA requires similar lighting control for runway and airport lighting. Innovative application of this technology would also make its way to commercial lighting for buildings, stores, etc. where innovative lighting solutions could directly replace incandescent lamps without providing new controls.

REFERENCES:

1. MIL-STD-1399(NAVY), "Interface Standard For Shipboard Systems, Section 300a Electric Power, Alternating Current"
2. MIL-STD-461E, "Requirements For The Control Of Electromagnetic Interference Characteristics Of Subsystems And Equipment"
3. MIL-S-901D "Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment, And Systems"
4. MIL-STD-810F, "Department Of Defense Test Method Standard For Environmental Engineering Considerations And Laboratory Tests"

KEYWORDS: LED; NVD; shipboard lighting; Naval aviation; deck; incandescent

N04-082 TITLE: Blast Protection and Damage Mitigation Coatings

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IC; DDG 51; PMS 400D

OBJECTIVE: Develop advanced coatings that can be applied to ship structures to provide blast protection and mitigate damage from fragmentation.

DESCRIPTION: Fragmentation produced by explosive blasts from terrorist bombs, as seen on the USS COLE (DDG 67), or from conventional military explosives, such as mines and grenades, can damage structures and injure personnel. Additionally, blasts that occur at or below the ship's waterline create internal flooding. If bulkheads are prevented from breaking apart, flooding can be prevented or minimized. There are some polymer coatings (polyurea, polyurethane, and hybrid polymers) currently being used in industry, but they do not meet the requirements for shipboard application.

Innovative polymer coatings that provide blast and fragmentation protection must meet shipboard fire, smoke, and toxicity requirements. The coating should be lightweight, easy to apply on steel, cure rapidly, and be readily repairable. The material should be easy to modify to allow penetrations or additions without significantly reducing the protective properties of the material. The coatings should have good adhesion to substrate in high humidity, wear and tear environments, and should not degrade existing corrosion protection to metallic substrates.

PHASE I: Demonstrate the feasibility of an innovative coating that will mitigate blast fragmentation and provide blast protection. Conduct bench scale testing as appropriate and develop application and validation plans. Recommend best concept for Phase II.

PHASE II: Finalize the design from Phase I and fabricate a prototype system. Through laboratory testing, validate the properties of the system as defined in Phase I. Conduct life-cycle and environmental testing. Refine and demonstrate the application and installation approach. Demonstrate a method to repair the prototype system.

PHASE III: Working with the Navy and commercial industry, develop a full-scale application for testing and installation on a ship.

PRIVATE SECTOR COMMERCIAL POTENTIAL: As seen by the terrorist attack on the French tanker LIMBURG, a blast mitigation coating would be applicable to both the commercial shipping industry and the commercial construction industry that are potential targets of terrorism. Such coatings would also be useful in mitigating injuries to workers in industrial environments where high pressure pipes, gas containments, or other equipments are subject to explosive fracture when damaged.

REFERENCES:

1. U. Sorathia, G. Long, M. Blum, J. Ness, T. Gracik; "Performance Requirements for Fire Safety of Materials in U.S. Navy Ships and Submarines", Proceedings of 46th International SAMPE Symposium and Exhibition, Volume 46, Book 2, May 2001.
2. U. Sorathia and C.P. Beck, "Fire-Screening Results of Polymers and Composites," Proceedings of Improved Fire and Smoke Resistant Materials for Commercial Aircraft Interiors, National Research Council, Publication NMAB-477-2, National Academy Press, Washington, DC (1995)
3. ASTM D638-02a, "Standard Test Method for Tensile Properties of Plastics"
4. ASTM E162-02a, "Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source"
5. ASTM E662-01, "Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials"
6. K.J. Knox, M.I. Hammons, T.T. Lewis, J.R. Porter, "Polymer Materials for Structural Retrofit"

KEYWORDS: Coatings; Protection; Blast; Mitigation; Elastomer; Polymer

N04-083 TITLE: Standoff Weapons-Barrier System

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: ACAT IC; DDG51; PMS 400D

OBJECTIVE: An innovative system concept to provide close-in defense against threats that are missed by outer defense layers.

DESCRIPTION: In the event a threat weapon (e.g. sea skimming missile or small boat) penetrated outer defense layers, a Standoff Weapons-Barrier would rapidly deploy to protect the ship. The barrier could be deployed by conventional propellants, explosives, compressed air or other mechanical or chemical means. The lethal mechanism could be, but is not limited to, projectiles such as in Metalstorm ™, shaped change blast fragments as with Claymore mines, blast overpressure from a detonated explosion, etc. The barrier should cause sufficient damage to the threat so that it could not continue on to impact the ship. Non-lethal systems that defeat the fuzing and electronics of the threat so that it could not detonate are also of interest. The barrier must have the potential to defeat multiple threats in a single engagement. Weapon detection and engagement information would be provided by the ship's self-defense system. The proposed barrier system must be able to respond at various distances appropriate to the weapon type and attack direction. The system must be capable of deploying both manually and automatically.

PHASE I: Demonstrate the feasibility of a standoff weapons-barrier system concept. The system should include the barrier, deployment method, and address any necessary information from or interfaces with the ship's combat system. Establish performance goals and provide a plan for development and demonstration of the key system components and challenges.

PHASE II: Design, build a scaled prototype as defined in Phase I. In a laboratory environment conduct a scaled capabilities demonstration. Provide a plan for implementation on a naval vessel.

PHASE III: Working with the Navy and commercial industry, develop a shipboard prototype system for installation and demonstration in an applicable operating environment.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A standoff weapons-barrier system is applicable to the commercial shipping industry, particularly in areas subject to high pirate activity, such as the Indian and west Pacific Oceans. The system could also be used to defend ports, oil platforms, and transfer facilities against terrorism.

REFERENCES:
1. "Water Barrier Ship Self Defense Lethality"; Naval Engineers Journal July 2000; pp121-135, Charles E. Higdon, NSWCDD, Dahlgren, VA.
2. "Measures of Effectiveness for the Information Age Navy, Chapter Three: Cruise Missile and Ballistic Missile Defense"; Rand Corporation 2002, W. Perry, R. Button, J. Bracken, T. Sullivan, J. Mitchell
3. "Kamikazies, Q-Ships and Carriers"; Proceedings December 2001, M. Stanton

KEYWORDS: Barrier; Close-in Defense; Fragmentation; Missile, Ship Defense; Protection

N04-084 TITLE: De-icing Systems for Shipboard Composite Structures

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IC: DDG51; PMS 400D

OBJECTIVE: Develop an effective system for preventing or removing ice from composite structures.

DESCRIPTION: Ice accumulation on a ship's weather deck and superstructure can result in significant added topside weight. This added weight reduces the operating envelope of the ship and, in severe cases, can endanger the seaworthiness of the vessel. The primary means of de-icing steel or aluminum structures on ships today consists of physical removal of the ice by impact with sledgehammers and aluminum baseball bats. This method is crude but sufficient for traditional ship structures. With the introduction of composite structures into the fleet, de-icing methods are required that do not result in impact damage to the composite materials.

Consideration will be given to both portable and integrated systems. Portable systems should be safely operable by no more than two sailors under extreme environmental conditions (i.e., high winds, high sea state, rain, snow, hail and extreme cold). Concepts that integrate a de-icing system into or on the composite structure must be compatible with shipyard composite manufacturing processes as well as ship design requirements for structural integrity, material compatibility, electromagnetic suitability and stealth. Both portable and integrated system concepts must be lightweight and must not require excessive demands on the ship's hotel services (electrical, potable water, compressed air). If proposed, de-icing fluids must not damage ship's structure (both composite and steel) and must meet existing environmental requirements as well as shipboard requirements for fire, smoke and toxicity.

PHASE I: Demonstrate the feasibility of an innovative concept for preventing or removing ice from composite structures on naval vessels. Establish performance goals and provide a plan for the practical deployment of the proposed concept on a naval vessel.

PHASE II: Finalize the design concept from Phase I and fabricate a prototype system. Through laboratory testing, validate the ability of the system to meet the performance goals established in Phase I.

PHASE III: Working with the Navy and commercial industry, develop a full-scale system for installation and testing on board a naval vessel.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This topic is applicable to the commercial shipping and ferry industries and may also, depending upon concepts proposed, be applicable to de-icing of composite or aluminum aircraft wings and fuselages.

REFERENCES:
1. Cold Weather Handbook for Surface Ships, OPNAV P-03C-01-89, US Navy, CNO, Washington, DC. 1988.
2. Ryerson, C., Superstructure Spray and Ice Accretion on a Large U.S. Coast Guard Cutter, in Proceedings of the 6th International Workshop on Atmospheric Icing of Structures, Budapest, Hungary, p. 280-285.

KEYWORDS: Composites; De-icing; Maintainability; Ice Removal; Extreme Cold

N04-085 TITLE: Lightweight Passive Fire Protection System for Composite Structures

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IC; DDG51; PMS 400D

OBJECTIVE: An affordable, lightweight passive fire protection system suitable for use on composite ship structures.

DESCRIPTION: The Navy currently uses high temperature glass fiber or mineral wool insulation products on ships to meet established fire safety goals. Surface ship fire safety goals include limiting fire spread (fire resistance), preventing flashover between compartments (fire growth), and maintaining environmental tenability (smoke and fire gas toxicity). Fire resistance criteria consists of maintaining a backside peak temperature rise of less than 325°F and average temperature rise of less than 250°F when subjected to a UL-1709 fire for 30 minutes or more. Fire growth is evaluated based on the performance after 20 minutes in an ISO-9705 room corner fire test.

Due to a combination of ship impact (weight), installation (attachment method), and cost (both manpower and material) factors, the Navy is seeking more cost effective, lightweight passive fire protection systems for use on composite structures that are beginning to enter the fleet. These systems may include high temperature coatings as well as insulation blankets, felts and mats, or some combination of these coatings and materials or other innovative concepts. Technical issues to be addressed include application and/or attachment procedures to composite substrates; the effectiveness of the system to meet fire resistance and fire growth tests; and an assessment of shipboard impacts including: cost, weight and thickness. All proposed concepts should possess general physical properties compatible with a shipboard environment; these include the moisture and salt effects of the seaway environment, resistance and durability to impact damage and survivability when subject to shock.

PHASE I: Demonstrate the feasibility of the proposed concept for an innovative passive fire protection system. Conduct limited testing to demonstrate viability of the concept and support recommendations. Establish performance goals and develop key component developmental milestones.

PHASE II: Finalize the design and fabricate a prototype passive fire protection system. Demonstrate performance of the system by conducting ISO 9705 room corner testing and UL-1709 panel testing with composite structures. Develop a plan for the practical implementation and demonstration on a naval vessel.

PHASE III: Working with the Navy and commercial industry, develop a shipboard system for installation and demonstration on a naval vessel.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Fire protection for composite construction is applicable to commercial shipbuilding, offshore platforms, and various transportation related industries. Depending upon the concepts proposed and their suitability for adaptation to use on steel substrates, the passive fire protection system could have very widespread applicability among the building industry, particularly large structural steel office and residential buildings.

REFERENCES:
1. U. Sorathia, G. Long, M. Blum, J. Ness, T. Gracik; "Performance Requirements for Fire Safety of Materials in U.S. Navy Ships and Submarines", Proceedings of 46th International SAMPE Symposium and Exhibition, Volume 46, Book 2, May 2001.
2. U. Sorathia and C.P. Beck, "Fire-Screening Results of Polymers and Composites" Proceedings of Improved Fire and Smoke Resistant Materials for Commercial Aircraft Interiors, National Research Council, Publication NMAB-477-2, National Academy Press, Washington, DC (1995)
3. ASTM E162-02a, "Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source"

KEYWORDS: Fire Insulation; Fire Resistance; Fire Growth; Composites; Smoke; Toxicity

N04-086 TITLE: Integrated Bridge Sonar Interface and Object Avoidance

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT 1 – DD(X)

OBJECTIVE: Development of an innovative process to improve shipboard situational awareness of mines and debris while providing the capability to assist in minefield transit.

DESCRIPTION: Currently, the Voyage Management Systems (VMS) used in the fleet provides a radar overlay, track target overlay, and collision avoidance capability. This topic will enhance these capabilities by providing an interface with the shipboard sonar systems thereby allowing automated mine and debris avoidance. The approach presented will allow for the display of mines and mine-like objects detected by the sonar systems on the electronic charting system. This will give the navigation team an integrated picture of the chart, surface, and sub-surface hazards. Once a comprehensive awareness is provided, a computer generated plan of ship's movement will be displayed on the electronic chart. If accepted by the user, the user will then have the option to automatically execute mine avoidance procedures.

This target outcome of this project is a prototype demonstration that integrates the ship's VMS, steering system, and sonar system in such a manner to provide a comprehensive display of mines and mine-like objects on the electronic chart as well as providing the capability for automated mine avoidance through changes in the ship's course and/or speed.

PHASE I: Demonstrate the feasibility of the proposed concept for interfacing the shipboard VMS and steering systems with mine detection systems to enhance object avoidance. The proposed concept should consider the projected hardware and software requirements, for an affordable, innovative process to achieve the stated objective.

PHASE II: Based on Phase I design, develop a prototype VMS / Sonar interface toolset. Analyze and demonstrate capabilities using laboratory modeling and simulation methods. Provide report documenting the approach and methodology employed, addressing future system enhancements as well as projected life cycle costs.

PHASE III: Working with the Navy, develop implementation plans and demonstrate capability in a shipboard environment through pier side and at-sea testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology can be used in search and rescue, undersea exploration, and possibly oil exploration. The technology could be adapted to serve as an object avoidance system for commercial vessels that operate with minimal manpower in waters with surface and sub-surface hazards.

REFERENCES:

1. "AN/WLD-1 RMS Remote Minehunting System" www.fas.org/man/dod-101/sys/ship/weaps/rms.htm
2. Sonar Navigation Systems, http://www.iee.org/oncomms/pn/radar/index.cfm
3. Radar, Sonar and Navigation Proceedings, http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?puNumber=2198
4. International Maritime Organization Guidance, http://www.imo.org/Safety/mainframe.asp?topic_id=355

KEYWORDS: Integrated Bridge System; Sonar; Mine avoidance; Situational Awareness; Ship Control; Collision Avoidance

N04-087 TITLE: Automated Asset Deployment and Retrieval System from Organic Offboard Vehicles (OOVs)

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT 1 – LCS

OBJECTIVE: The development of an automated Deployment and Retrieval (D&R) system that can deploy a variety of towed sensors, sources, and arrays from unmanned Organic Offboard Vehicles (OOVs).

DESCRIPTION: It is projected that the military will employ growing numbers of unmanned autonomous vehicles to perform a variety of functions. These functions are often performed by further deployment of sensors, sources and arrays from the OOV's. In the past, a dedicated deployment and retrieval (D&R) system has been developed for each sensor and array system after it has already been well defined. A single system capable of deploying many different towed assets, whether sensors, arrays, etc., will enable OOVs to reach their full multi-mission potential.

A common deployment and retrieval D&R system that can deploy a variety of multiple towed assets from OOVs including, but not limited to, systems incorporating multi-diameter cables, towed bodies, dipping sonars, towed arrays, combination bare/faired cables, etc. The system must be compact and lightweight, and capable of fully remote operation. In addition, depth changes must be able to be executed quickly. The application of open system architecture, such as using industry standards for interfaces, as well as the use of COTS, where possible, is encouraged.

PHASE I: Demonstrate the feasibility of a lightweight, automated D&R system suitable capable of handling multiple towed sensor/source/array systems. Provide drawings, descriptions of projected capabilities, operating concepts and sequences, and weight and cost projections.

PHASE II: Fabricate and demonstrate a prototype system developed in the Phase I effort. Through laboratory testing, validate the properties of the system as defined in Phase I. Revise drawings, descriptions, and projections as applicable.

PHASE III: Conduct at-sea testing on board a Navy USV. Provide sea trial reports, and finalize all documentation and manuals.

PRIVATE SECTOR COMMERCIAL POTENTIAL: A common, lightweight and compact D&R system capable of handling many different types of towed array and sensor systems would be valuable to oceanographic research institutions or offshore exploration companies.

REFERENCES:

1. "LCS Mission System Technical Architecture Requirements", available upon request.
2. Open Modular Architecture, http://www.acq.osd.mil/osjtf/

KEYWORDS: Deployment and Retrieval; Unmanned Surface Vehicle; USV; Unmanned Undersea Vehicles; UUV; Organic Offboard Vehicle; OOV

N04-088 TITLE: Configuration Management and Monitoring System for Mission Module Interfaces

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT 1 – LCS

OBJECTIVE: Development and demonstration of a system that will provide an innovative approach to health monitoring and configuration management of shipboard module interfaces for ship vehicles and other modular systems. The system developed will provide diagnostic state-of-the-interface data after initial installation and through out a ships mission.

DESCRIPTION: Navy ships of the future will require the ability to be able to reconfigure "plug-in" modules between missions. These modules could be unmanned vehicles, surveillance or combat related. A ship that employs an open "plug and fight" architecture will be to be flexible enough to quickly and efficiently remove and replace module while providing assurance that the new or replaced module has interface connectivity throughout the mission. The module will be required to interface mechanically and electronically with the ships hull, mechanical and electrical systems as well as integrating with the command, control and communication system.

This proposed system should provide an innovative approach to health monitoring and configuration management of shipboard module interfaces for ship vehicles and other modular systems. The module to be considered for this topic includes, but is not limited to the following:

- The module examples: Unmanned vehicle (vehicle & command and control system); gun systems; sensor systems (radar, infrared search and track, electro-optical)

- Interface Function: Command, Control & Communications (C3); mechanical and electrical; power, air, hydraulic and/or other ship services need to operate the module.

- Monitoring System Attributes: Automated non-manned in the loop, expandable, user display, centralized management control, integration with ship's network.

This system must have low acquisition and lifecycle costs, be mechanically / electronically simple, provide adequate security and provide for safe ship operation in a variety of shipboard conditions including high ship speeds and up to Sea States (SS) 5. The system must also be capable of operation in the harsh Navy unique environment including requirements for shock and vibration and must be capable of use on multiple Navy ships. The system can employ combination of wired and wireless LAN integral with the ship.

PHASE I: Demonstrate the feasibility of the development of a low cost system concept and architecture that will allow for the monitoring and management of mechanical and electronic interfaces as well as providing diagnostic interface states for shipboard plug and play modules after installation and throughout a ships mission. Propose measures of effectiveness for the validation of the system check diagnostic algorithms.

PHASE II: Fabricate and validate a prototype of the system developed in Phase I. Develop generic system check diagnostic algorithms as discussed during Phase I. Provide acquisition and lifecycle cost estimates.

PHASE III: Conduct shipboard testing to evaluate performance in the Navy environment and develop plans for shipboard certification and application. Develop concept of operations and detailed capabilities, detailed drawings and specifications, operating sequences and limits, weight and system cost estimates (both acquisition and lifecycle), and manning/Human Systems Interface (H.S.I.) requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The interface configuration management system and/or generic diagnostic algorithms developed could increase reliability and cost effect operation of heavily modularized systems. Interface health monitoring facilitates condition-based maintenance by using systems faults to diagnose and make repairs before cascading system failure occurs. The system could be applied to any critical system such as aviation modules within an airframe and space related systems (launchers and vehicles).

REFERENCES:

1. Naval Air Systems Command PMA-263 Unmanned Aerial Vehicles website, http://uav.navair.navy.mil/home2.htm
2. Open System Approach to Weapon System Acquisition, By Open System Joint Task Force.
3. DOD instruction: DoD Information Technology Security Certification and Accreditation Process (DITSCAP)
4. Specific systems interface requirements will be provided upon request.

KEYWORDS: modules; health monitoring; plug-n-play; open interfaces; CBM; Unmanned Vehicle

N04-089 TITLE: Improved Optics for Overhead Flood Lights

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT IVT; Amphibious Warfare Program

OBJECTIVE: Develop low-cost, conformal, optical concepts for shipboard overhead floodlights to optimize flight deck light distribution.

DESCRIPTION: The lighting provided by existing overhead flood lights creates uneven lighting across the flight deck due to the low grazing angles of the lights. This is caused by the restrictive placement of the lights and generally results in problems for pilots landing at night and/or in heavy weather as they are critically reliant on visual cues provided by the lighting of the ships' horizontal and vertical surfaces.

The development of optical concepts is desired that would allow for a more constant and reliable distribution of light across the flight deck while potentially minimizing the number of required fixtures. The solution proposed shall be conformal to the skin of the existing ships' structure and shall be able to accept source light through fiber optic bundles. The solution proposed shall also allow for the ability to "switch" between Nigh Vision Device (NVDs) and normal deck lighting schema. The concept should provide adequate deck lighting while not compromising the night vision capability of pilots and deck personnel by direct viewing.

PHASE I: Demonstrate the feasibility of the concept and propose preliminary design. Develop key component and technological milestones.

PHASE II: Develop a prototype based on the design concept selected from Phase I. Provide a detailed test plan, finalize and conduct a scaled capabilities demonstration of the prototype. Address the potential for shipboard replacement as well as the ability to meet shipboard environmental requirements.

PHASE III: Design and fabricate full-scale. Provisions will be made to facilitate shipboard lighting testing of light fixtures and/or the entire ship's deck surface and overhead lighting system as deemed appropriate. Subsequent to system refinement and all first article testing, selected components will be lab tested and shipboard demonstrated.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Lighting technologies such as non-imaging and holographic optics have wide application in the lighting field. The FAA requires similar lighting systems for runway and airport lighting. Outdoor lighting for security and general illumination for sporting events also have similar applications. Innovative application of lighting technologies would also be transferable to commercial lighting for buildings, stores, etc. where custom optics could provide uniform illumination at low cost with a minimum of fixtures.

REFERENCES:

1. MIL-S-901D, "Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems"
2. MIL-STD-1399(NAVY), "Interface Standard for Shipboard Systems, Section 300a Electric Power, Alternating Current"
3. MIL-STD-461E, "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment"
4. MIL-STD-810F, "Department Of Defense Test Method Standard for Environmental Engineering Considerations and Laboratory Tests"

KEYWORDS: optics; NVD; night vision devices; conformal; shipboard lighting naval aviation

N04-090 TITLE: Advanced Structural Development for Naval Hovercraft Ramps

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IVT; Amphibious Warfare Program

OBJECTIVE: To develop durable, lightweight bow and stern ramps that will improve payload lift capacity and reduce corrosion, weight, and life-cycle costs.

DESCRIPTION: The Landing Craft Air Cushion (LCAC) vehicle, which is a Navy hovercraft, has welded aluminum bow and stern ramps to provide roll-through capability for loading and unloading equipment and personnel. The ramps are heavy and prone to damage due to the uniquely harsh environment in which the LCAC operates. This environment includes exposure to salt, sand, sediment, seawater spray as well as machinery oils from offloaded equipment.

This topic seeks innovative advanced materials and structural concepts to provide a lightweight ramp that is resistant to the environment challenges inherent in the operating arena while handling large loads up to 70 tons. Addressing these challenges will increase the ruggedness and durability of these ramps which in turn will reduce life-cycle and maintenance costs. A reduction in weight while maintaining the structural integrity will allow for an increase in the payload lift capacity of the vessel. The current ramps are hydraulically operated. The proposed design must be able to interface with the existing attachment points and pulley system. The proposed structure shall conform to current ramp size and stowage constraints. During technology development and fleet integration, testing will be conducted that will include functionality demonstrations and roll-on/roll-off trials of various Marine Corps vehicles including the Abrams M1A1 tank.

PHASE I: Conduct a feasibility analysis to determine the best durable, lightweight material and structural concepts for the construction of the ramps. Provide a preliminary concept design and an associated component validation plan.

PHASE II: Finalize the design from Phase I and fabricate prototype panels. Validate prototype using laboratory testing and provide results.

PHASE III: Construct a full scale prototype based on Phase II results for testing in a shipboard environment. As applicable, the small business will work with the Navy or Industry to transition the technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial ferries and cargo ships that load and unload vehicles and heavy equipment would benefit from the design and technology development of durable, lightweight ramps. Trucks which use ramps for loading, such as moving or delivery trucks, would also benefit from the durability and weight savings this technology would provide.

REFERENCES:
1. http://www.fas.org/man/dod-101/sys/ship/lcac.htm
2. LCAC Tech Manual - S9169-AC-MMA-010 Bow and Stern Ramp System

KEYWORDS: Landing Craft Air Cushion; LCAC; Lightweight; Advanced Materials; Ramp; Loading

N04-091 TITLE: Advanced Structural Development for the Personnel Transport Module (PTM)

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IVT; Amphibious Warfare Program

OBJECTIVE: To develop a durable, lightweight Personnel Transport Module (PTM) that will reduce corrosion, weight and life-cycle costs, add ballistic protection, improve human conditions (i.e. improve airflow and reduce noise) thereby improving craft performance.

DESCRIPTION: The PTM is used by the Navy to deliver up to 180 combat ready Marines or 54 litters (when used in Medical Evacuation operations) from ship to shore aboard LCAC's (Navy hovercraft). The PTM is a modularized structure designed to secure to the open cargo deck of LCAC. Its purpose is to increase the capability of LCAC to transport personnel and protect occupants from the elements inherent in an amphibious environment. The unique environment in which this littoral vessel operates exposes the modules to salt, sand, seawater spray as well as potential ballistic hazards.

This topic seeks innovative advanced materials and structural concepts to provide an easy to assemble structure that is corrosion resistant while providing ballistic protection at a much lower weight. The proposed PTM structure will need to be assembled by personnel, be multi-configurable, and consist of one to six sections. Each section shall be portable and any combination of sections should be able to serve as a stand-alone unit. The proposed structure shall conform to current PTM size, stowage, and habitability constraints. The small business is encouraged to explore design modifications that could improve ventilation and reduce noise levels as well as provide other quality of life improvements. Specific testing or verification to be addressed during development and fleet integration will include, but is not be limited to: structural and mechanical/materials integrity, external wind loads, vibration testing, erection time, and habitability operations.

PHASE I: Conduct a feasibility analysis to determine the best durable, lightweight material and structural concepts for the construction of the modular PTM. Provide a preliminary concept design and an associated component validation plan.

PHASE II: Finalize the design from Phase I and fabricate a prototype panels and associated joints. Validate prototype using laboratory testing and provide results. Develop a scaled PTM model to demonstrate the required personnel capacity and human factors requirements.

PHASE III: Construct full size PTM with the option of 180 seats or 54 litters in place to be installed and tested in a shipboard environment. As applicable, the small business will work with the Navy or Industry to transition the technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Construction companies, oil and mining industries could directly utilize these modules as portable shelters and/or work spaces. These same industries experience extremes in operating environment conditions and carry a hazard of high pressure pipes, gas containments, or other equipments that are subject to explosive fracture when damaged.

REFERENCES:
1. http://www.fas.org/man/dod-101/sys/ship/lcac.htm

2. LCAC Top Level Requirements (TLR) - OPNAVINST C9010.319
3. LCAC SEAOPS Manual Volume III - S9LCA-AA-SSM-040

KEYWORDS: Personnel; Transport Module; Landing Craft, Air Cushion; Lightweight Materials; Advanced Materials; Durable Materials

N04-092 TITLE: Unmanned Vehicle (UV) to Stern Ramp Launch and Recovery Interface

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: ACAT 1 – LCS

OBJECTIVE: Develop and demonstrate an interface to secure multiple types of unmanned vehicles to the stern ramps of small deck ships.

DESCRIPTION: The majority of existing and projected future unmanned vehicles are Unmanned Undersea Vehicles (UUV) and Unmanned Surface Vehicles (USV) of varying size and shapes. Currently, there is no safe and accurate method for the recovery of UUVs and USVs aboard ship. The Navy anticipates these UVs will primarily be launched and recovered from ships using stern ramps since this configuration has the least impact upon ship and UV operations. Design and installation of special launch and recovery systems for each specific UV would be both costly and limit the Navy's ability to utilize UV capabilities.

The system proposed shall provide an innovative approach to positively secure multiple types of UVs using a common interface system for stern ramp launch and recovery. This system will enable small deck ships to exploit the large array of UVs with minimum risk to the vehicle, ramp, ship, or shipboard personnel. Upon completion of a recovery, the system shall be either automatically or with minimal manpower, removed and/or stowed. Due to potentially limited overhead space on the ship, a low profile design (minimal height) is desirable. Consideration must be given to innovative controls, materials, and mechanical designs and must take into consideration that UV's potentially have many sensitive areas (forward looking sonar, etc.) and require a fairly soft interface or location specific contact areas. Due to the potentially high differential velocity of the vehicle and ship during recovery operations, some impact/shock mitigating features may be a desirable feature/consideration.

This system must have low acquisition and lifecycle costs, be mechanically simple, and provide for safe ship operations in a variety of shipboard conditions including high ship speeds and up to Sea States (SS) 5. The system must require no redesign impact on the UVs to preserve UV performance and promote use with multiple and varied UVs on multiple ship platforms. The system must take into account open system architecture principles.

PHASE I: Demonstrate the feasibility of the proposed concept to develop a lightweight, low cost, UV to stern ramp interface for safely launching, recovering and securing multiple types of UVs. Define the proposed concept of operations and projected capabilities. Develop key component technological milestones.

PHASE II: Fabricate and demonstrate a prototype of the system developed in Phase I. Through land-based testing, demonstrate the prototypes ability to launch, recover and secure a variety of UVs in simulated shipboard conditions. Refine concept of operations and projected capabilities. Provide drawings and operating sequences. Conduct lifecyle testing and provide system cost estimates (both acquisition and lifecycle).

PHASE III: Conduct shipboard testing to evaluate performance in the Navy environment and develop plans for shipboard certification and application. Develop transition plans for the shipboard, joint services, and commercial uses of the system developed.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Multiple service (USCG, USMC, US Army), commercial ships, off-shore oil platforms, weather service, and survey firms could use a common launch and recovery system interface that would in turn allow for the capability to launch and recover a broad assortment of UV's.

REFERENCES:
1. Naval Ships Technical Manual, Chapter 583
2. Littoral Combat Ship Concept of Operations, Navy Warfare Development Command, September 2002

KEYWORDS: Unmanned Vehicle; UV; Launch; Recovery; Ship interface

N04-093 TITLE: Structurally Efficient, Low-Cost Joining Techniques

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IC; DDG51; PMS 400D

OBJECTIVE: Develop improved joining techniques for composite-to-composite and/or composite-to-steel structural joints.

DESCRIPTION: The use of composite structures in U.S. Navy ship applications requires low-cost, high strength joining techniques capable of resisting severe one-time combat loads as well as high seaway fatigue conditions throughout the 30-40 year life of the ship. The design of composite-to-composite joints is ultimately limited by relatively low out-of-plane material properties associated with laminated structures. Composite-to-steel joints are typically simple bolted and/or bonded joint designs that are costly to manufacture in a shipyard environment and/or highly dependant on tight manufacturing tolerances to achieve the expected performance. New concepts or design improvements in both of these joint configurations are solicited.

Methods to improve the ultimate load capacity of composite-to-composite t-joints, hat-stiffener attachments and panel-to-panel joints should address static, dynamic and fatigue performance enhancements through design optimization, material solutions or unique manufacturing processes. Methods to improve composite-to-steel joints should propose designs or construction methods that provide for lower manufacturing and assembly costs or significant performance enhancements over typical bolted joint configurations. Proposals for either solution should focus on typical marine composite construction materials such as E-glass reinforcements and vinyl ester resins with manufacturing processes suitable for large ship construction.

PHASE I: Demonstrate the feasibility of the new concept or the design improvement to increase the structural integrity of composite-to-composite and/or composite-to-steel structural joints. Conduct limited testing and/or analysis to demonstrate feasibility and support design recommendations. Establish performance goals for Phase II and provide a plan for concept validation.

PHASE II: Finalize the new concept or design improvement and fabricate prototype joints on full-scale structural components. Conduct laboratory testing to demonstrate joints meet the performance goals identified in Phase I. Conduct life-cycle and environmental testing. Develop a plan to design, fabricate, and install on a naval vessel a large-scale composite structure incorporating the new concept or improved design joint technology.

PHASE III: Working with the Navy and commercial industry, design, fabricate, and install a large composite structure on a naval vessel that incorporates the new concept or improved design joint technology.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Improved techniques for joining composite structure to both composite and steel structures apply to the commercial boat building industry, civil engineering infrastructure applications such as bridges and radio towers as well as various transportation applications such as railroad cars, busses and airplanes.

REFERENCES:
1. Phillips, H.J., and Shenoi, R.A., “Damage Tolerance of Laminated Tee Joints in FRP Structures”, Composites Part A – Applied Science and Manufacturing, Vol. 29, No. 4, pp. 465, 1998.
2. Meijer, G.J. et.al., “Dynamic Behavior of Composite Ship Structures – Test and Analyses Efforts”, Proceedings of the 70th Shock and Vibration Symposium, November 15-19, 1999.

KEYWORDS: Composite joints; Tee-joints; Composite-Metal joints; Sandwich panels; Hat-Stiffeners

N04-094 TITLE: Vinyl Ester Compatible, High Modulus Fiber System for Composite Laminates

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: ACAT IC: DDG51; PMS 400D

OBJECTIVE: Develop a carbon or other high modulus fiber reinforcement process that is fully compatible with vinyl ester resins in order to realize both the material strengths typical of E-glass vinyl ester composites and the stiffness typical of carbon composite materials.

DESCRIPTION: The standard composite laminate system used in several recent U.S. Navy composite structural applications consist of E-glass woven roving-fiber reinforcement in a vinyl ester resin that is fabricated using a vacuum assisted resin transfer molding process. These resin/fiber systems can achieve laminate material strengths greater than the yield strength of mild steel at a density of approximately 1/3 the density of steel. Unfortunately, due to the relatively low modulus of glass, the corresponding material stiffness of these laminates is only about 1/10 that of steel. Significant increases in laminate stiffness could be achieved if carbon fibers or other high modulus fiber material were used. However, previous composite development programs have not been able to identify carbon or other high modulus fiber reinforcements that are fully compatible with vinyl ester resins. Tests have shown a generally poor adhesion between carbon fibers and the resin, resulting in much lower than expected compressive strength and modulus.

The Navy is seeking an innovative process, sizing, or technique for treating carbon fibers or an alternative high modulus fiber material in order to increase bonding between the fiber and vinyl ester resin that would result in a composite material with increased strength and stiffness. Proposed solutions should be compatible with the standard marine composite vinyl ester resin systems and the manufacturing processes used for construction of large composite ship structures.

PHASE I: Demonstrate the feasibility of the proposed process or method to increase the adhesion between carbon fibers or an alternative high modulus fiber material and vinyl ester resin systems. Conduct limited material coupon testing to support feasibility demonstration and to support recommendations. Establish performance goals and develop key component technological milestones.

PHASE II: Finalize the process design and fabricate test articles. Conduct laboratory testing over a full range of material property characterization to include effects of elevated temperature, moisture, processing parameters and laminate configuration for selected vinyl ester resin systems. In order to validate the ability to economically produce improved carbon fiber using the innovative process, provide sufficient quantity of the improved carbon or alternative high modulus fiber for a large-scale demonstration in Phase III. Develop a plan to design and fabricate a large-scale test structure to be installed on a naval vessel.

PHASE III: Working with the Navy and commercial industry, design and fabricate a full-scale structure for test and installation on a naval vessel.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Low-cost vinyl ester resin systems are used extensively in commercial marine and transportation industry. The development of improved carbon or other alternative high modulus fiber reinforcements compatible with vinyl ester resins would improve individual product performance and broaden the commercial range composite materials.

KEYWORDS: Carbon; Vinyl Ester; fiber adhesion; sizing; composites; resin;

N04-095 TITLE: High Temperature, High Power Density Electronic Devices

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: ACAT 1 – DD(X)

OBJECTIVE: Research alternative methods for development of high power electronic devices capable of operating at high temperatures and power density.

DESCRIPTION: Power electronics based upon silicon transistor technology have reached design limits on size, weight, and efficiency due to heating. Current silicon power electronic devices are limited to junction temperatures of 200ºC and considerably less where high reliability is required. Silicon-carbide based electronics have the potential for reliable operations at higher junction temperatures and device density. This technology would allow operation of electronic systems in environments with ambient temperatures over 400ºC, which simplifies cooling and improves heat-transfer rates for shipboard cooling systems. Silicon-carbide based power electronics could also be operated at higher power density, which would reduce both shipboard weight and volume.

This topic seeks to resolve technical issues associated with the use of silicon carbide or alternative power electronics technology in a high temperature and power dense environment. For illustrative purposes, the proposer is asked to demonstrate, through analysis and laboratory demonstration, the design of a prototype high-horsepower, high-torque electric motor incorporating an integral pulse-width modulation power-servo control based upon silicon carbide or alternative power electronics technology. The proposed concept should be capable of operation in a high-reliability switching mode without active cooling. The concept should take into account shipboard extremes of temperature, humidity, shock, vibration, and electromagnetic effects.

PHASE I: Demonstrate the feasibility of developing silicon-carbide based, high-operating temperature, high-power density components for use in high-torque, high-precision servo systems. Conduct analysis and limited testing of scaled devices to demonstrate feasibility and support design recommendations. Establish performance goals and develop a plan for development and demonstration of a prototype device.

PHASE II: Develop a prototype device and test performance against goals established in Phase I. Prepare a plan for design and manufacture of a shipboard device.

PHASE III: Working with the Navy and commercial industry, complete the design and manufacture of a high-horsepower, high-torque electric motor possessing integral power control electronics incorporating a pulse-width modulation (PWM) control scheme, or equivalent scheme, compatible with servo power drives for use shipboard.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology has wide commercial potential as high-current, high-voltage diodes for power rectification, cellular telephone systems, power conditioning equipment, power switching devices, RF transmitters, and radiation hardened electronic equipment.

REFERENCES:
1. Johnson, C. M., et al, Silicon Carbide Devices for High Temperature High Power Applications, Review Report on EPSRC Grant GR/L62320/01, January 2002.

KEYWORDS: Silicon Carbide; Electronics; Power; IGBT; MOSFET; MESFET; Static Induction Transistor

N04-096 TITLE: RF Power Scavenging for Wireless Sensors

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT IV: PMS400F Smartship

OBJECTIVE: Development of radio frequency (RF) power scavenging technology that can power sensors.

DESCRIPTION: The Navy is reducing shipboard manning through automation, reducing maintenance on ships and systems, and the introduction of new technology that improves crew performance. These trends are resulting in a greater reliance on a very large number of shipboard sensors across a whole spectrum of functions. From a design, construction, life-cycle cost, and maintenance perspective, wireless communication between sensors and wireless access points is very attractive since it avoids installation of large numbers of wires. However, the use of batteries to power wireless sensors remains a major maintenance impediment to their use in large numbers. This topic seeks innovative methods to scavenge power from broadcast RF signals to power sensors. The solution developed must not interfere with RF data transfer between sensors and wireless access points and must be compatible with industry standard wireless protocols such as the IEEE 802.11 family, the IEEE 802.15 family (Bluetooth), and the emerging IEEE 1451.5 standard.

PHASE I: Demonstrate the feasibility of scavenging RF power and converting it into a form that can power a large variety of wireless sensors. Conduct limited testing of the concept to support feasibility demonstration and recommendations for Phase II effort. Establish Phase II performance goals and key developmental milestones and prepare a system concept to utilize the RF power scavenging technology.

PHASE II: Finalize the system and component designs and fabricate a prototype system. Perform laboratory tests to validate the performance goals established in Phase I and demonstrate the system's ability to scavenge RF power without degrading the data transfer capability between sensors and a wireless access point. Develop a plan to design, fabricate, and install a system on board a naval vessel.

PHASE III: Working with the Navy and commercial industry, develop and install a system on board a naval vessel.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology would have wide commercial application in manufacturing, power generation, and transportation industries that utilize large number of sensors and where maintenance costs and continuous operation are important. The technology would also have advantage in applications where access for battery replacement is limited or wire damage was likely.

REFERENCES:

1. http://grouper.ieee.org/groups/802/11/
2. ANSI/IEEE Standard 802.11, 1999 Edition
3. IEEE Std 802.11b-1999
4. IEEE Std 802.15.1-2002

KEYWORDS: sensor; wireless sensor; Wireless network; network; RF; communications

N04-097 TITLE: Conversion of Friable Asbestos Containing Materials into Non-hazardous Substances

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Identify new methods and technologies to be used in the field to convert friable asbestos containing materials (ACM) into non-friable states.

DESCRIPTION: Asbestos is a known carcinogen and as such poses a serious health hazard to personnel involved in repairing or removing asbestos containing materials (ACM), requiring the establishment of asbestos containment barriers, workspace environmental controls, and the use of personal protection equipment in accordance with Occupational Safety and Health Administration (OSHA) regulations, Title 29 Code of Federal Regulations (CFR) Section 1915. Inactive ships contain substantial quantities of potentially friable ACM, particularly thermal system insulation applied to bulkheads in machinery spaces, boiler gas exhaust uptakes, and pipe insulation as well as boiler refractory. During ship dismantling, ACM removal is a highly regulated and extremely labor intensive process accomplished under strict controls by trained State certified asbestos workers.

The Navy seeks an inexpensive and reliable method of converting friable ACM into a non-friable state that can be easily disposed of through standard bulk waste-disposal processes. The proposed concept should be usable in enclosed shipboard compartments and be able to be operated by a small number of personnel who have been trained in the process, but without the need for further specialized knowledge.

PHASE I: Demonstrate the feasibility of developing an inexpensive and reliable method of converting friable asbestos containing materials into a non-friable state while in-the-field. Conduct limited testing to support feasibility demonstration and to support recommendations. Establish performance goals and develop key component technological milestones.

PHASE II: Develop and fabricate a prototype set of equipments needed to process friable ACM. Demonstrate the capability over a range of ACM configurations typically found on ships. Validate results against samples tested at an independent laboratory. Provide an analysis of the potential cost saving associated with the proposed concept compared to the current means of friable ACM removal. Provide a plan to get the process certified by the EPA.

PHASE III: Fabricate a field-deployable version of the prototype system. Obtain U.S. OSHA approval of the friable ACM conversion process as an occupationally safe alternative. Upon receipt of EPA approval, work with ship dismantling contractors to provide training on the use of the developed process. Conduct a demonstration onboard one machinery space compartment of an inactive ship.

PRIVATE SECTOR COMMERCIAL POTENTIAL: ACM has been used throughout the world for many years as thermal insulation in buildings and other structures. A process that allows the conversion of friable ACM to a non-state for removal and disposal has wide industry applications with regard to building renovation or demolition.

REFERENCES:

1. EPA document 315-8-00-001, A Guide for Ship Scrappers, Tips for Regulatory Compliance, Summer 2000.
2. OSHA Regulation 29 CFR 1915.

KEYWORDS: Asbestos; ACM; Disposal; Remediation; Abatement; waste;

N04-098 TITLE: Bio-Remediation of Hydrocarbons on Inactive Ships

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a process that can be used in the field to make inactive ships essentially petroleum free prior to ship dismantling or sinking as an artificial reef.

DESCRIPTION: Inactive ships contain varying quantities of hydrocarbons (fuels, oils, greases) in tanks, piping, bilges, hydraulic equipment and lines, engines, and other machinery. Current cleaning processes include draining, flushing, and solvent cleaning to ensure all residual hydrocarbons are removed prior to ship dismantling or sinking. This is a labor intensive and time consuming process that generates substantial quantities of oily wastewater. These waste fluids in turn are treated and disposed of as oily waste and as hazardous waste by the ship dismantler.

The Navy seeks an inexpensive process to bio-remediate hydrocarbons onboard inactive ships thereby negating the need to drain, flush and clean before dismantling or sinking as an artificial reef. Prior to ship dismantling, the ship should be safe for hot work and safe for workers. Prior to sinking, the ship should be environmentally compatible for use as an artificial reef. The process proposed should be portable, usable in enclosed shipboard compartments, able to be operated by a small number of personnel (one is preferred) who have been trained in its operation but without the need of further specialized knowledge.

PHASE I: Demonstrate the feasibility of developing an inexpensive and reliable process to bio-remediation residual hydrocarbons from ship structures and equipment prior to ship dismantling or sinking as an artificial reef. Conduct limited testing to support feasibility demonstration and to support recommendations. Establish performance goals and develop key component technological milestones.

PHASE II: Develop and fabricate a prototype system. Demonstrate the process developed in Phase I. Validate results against samples tested at an independent laboratory. Provide an analysis of the potential cost savings associated with the proposed process to bio-remediate hydrocarbons compared to the current method of draining, flushing and cleaning with solvents.

PHASE III: Fabricate a deployable system and demonstrate process onboard an inactive ship. Develop a cost model and a plan for the implementation onboard other inactive ships remaining in both the Navy and U.S. Maritime Administration's inventory.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Hydrocarbon bio-remediation processes are directly applicable for use onboard historic naval museum ships to reduce their long-term environmental liabilities and to the domestic ship building industry to reduce the generation of wastes necessary to clean tanks and piping onboard ships prior to repair or preservation. The process developed also has applicably for the clean-up of oil spills in both water and hazardous petroleum on land.

REFERENCES:
1. EPA document 315-8-00-001, A Guide for Ship Scrappers, Tips for Regulatory Compliance, Summer 2000.

KEYWORDS: Hydrocarbons; Oils; Fuels; Remediation; Cleaning; Ships

N04-099 TITLE: Explosive Cutting Technologies Applied to Ship Dismantling

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Determine the technical feasibility of safely applying explosive cutting technologies to ship dismantling.

DESCRIPTION: Ship dismantling is the most environmentally sound approach to ship disposal but is also the most expensive alternative because material cutting processes are labor intensive. Under current ship disposal practice, ferrous materials are cut using hand-held propane or oxy-acetylene torches. Structures such as armor plating, ballistic plating, damage control decks, propulsion shafting, and irregular surfaces are particularly difficult and costly to cut-up. Cold cutting techniques, such as power saws and hydraulic shears, are used to cut non-ferrous materials.

In order to reduce the cost and time associated with the dismantling of inactive ships for disposal, the Navy is interested in developing or adapting explosive cutting technology to replace current labor-intensive practices. The technology proposed must be compatible with marine, shipyard, and personnel safety requirements as well as be compliant with noise exposure ordinances and practices.

PHASE I: Demonstrate the feasibility of developing or adapting explosive cutting technologies for the ship dismantling process. Establish Phase II performance goals and develop key component technological milestones. Identify key implementation issues such as explosive material handling and permits, personnel and ship safety, level of engineering control required, and impact on the marine environment and recommend Phase II efforts to resolve.

PHASE II: Demonstrate the explosive cutting technique or system in a laboratory environment on multiple types of ferrous and non-ferrous materials and structures. Validate achievement of the performance goals established in Phase I. Provide an analysis of the potential cost saved using the proposed concept compared with the currently used dismantling techniques. Working with the Navy, provide a plan for demonstration of the proposed explosive cutting approach on a Navy Ship Dismantling Project (SDP).

PHASE III: Working with the Navy and a Navy Ship Dismantling Project (SDP) contractor, implement a demonstration project to use the explosive cutting technology to dismantle all or portions of one of the Navy's inactive ships. Validate the cost savings addressed in Phase II. As necessary, support the Navy and the contractor by developing a detailed explosives handling and occupational safety management plan.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Explosive cutting technologies have practical application to heavy industry, marine, and bridge demolition projects. Specifically this technology could be used in the dismantling of commercial ships, oil rig platforms, bridge structures, and large manufacturing installations.

REFERENCES:
1. EPA document 315-8-00-001, A Guide for Ship Scrappers, Tips for Regulatory Compliance, summer 2000.

KEYWORDS: Explosive cutting; Disposal; Ships; Steel cutting; Demolition; Recycling

N04-100 TITLE: Automated Polychlorinated Biphenyl (PCB) Analyzer for Solid Waste Material

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a method that can be used in the field to identify and characterize solid materials containing polychlorinated biphenyl (PCB).

DESCRIPTION: Polychlorinated Biphenyl (PCB) was commonly manufactured from the 1930's through the early 1970's and was used in a number of materials found on ships. Materials containing PCB's in concentrations of 50 parts per million are regulated under the Toxic Substances Control Act and under Title 40 Code of Federal Regulations (CFR) and require specialized and costly disposal methods. Inactive ships contain numerous solid materials that may contain concentrations of PCB in excess of the regulated amounts. When dismantling inactive ships, it is difficult to characterize the hundreds of potential toxic materials without laboratory analysis, which is both expensive and can delay the ship dismantling process for up to a month.

The Navy seeks an inexpensive and reliable method to field test solid materials to accurately determine the presence and concentration of PCB's. These materials include, but are not limited to, felt gasket and faying material, electric power cable insulation, thermal insulation, applied paints, and various rubber products. The proposed concept should be portable, usable in enclosed shipboard compartments, able to be operated by a small number of personnel (one is preferred) who have been trained in its operation, but without need of further specialized knowledge, and able to produce timely and repeatable results.

PHASE I: Demonstrate the feasibility of developing a quick, reliable, field test method to determine PCB concentrations of various solid materials. Conduct limited testing to support feasibility demonstration and to support recommendations. Establish performance goals and develop key component technological milestones.

PHASE II: Develop and fabricate a prototype of an automated PCB analyzer based on the proposed concept. Demonstrate operation of the prototype in a laboratory environment by sampling and analyzing multiple types of solid waste. Validate results against samples tested at an independent laboratory. Provide an analysis of the potential cost savings associated with the proposed in-situ concept compared with the current laboratory testing methods.

PHASE III: Fabricate a field-deployable version of the prototype PCB analyzer. Develop and execute a detailed plan to obtain U.S. EPA approval of the automated PCB analyzer as an acceptable alternative to laboratory analysis utilizing EPA Method 8082 or other EPA methods. Upon receipt of EPA approval, fabricate additional field-deployable PCB analyzers and work with ship dismantling contractors to provide training on their use.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The electrical power industry, among others, recognizes PCBs as a problem in the disposal of certain solid materials. An automated PCB analyzer could have significant commercial potential in various demolition or repair projects to properly characterizing solid materials for disposal, thereby reducing the volume of materials improperly generalized as toxic wastes and preventing the inadvertent disposal of PCB waste as solid waste.

REFERENCES:
1. EPA document 315-8-00-001, A Guide for Ship Scrappers, Tips for Regulatory Compliance, summer 2000.
2. EPA regulation 40 CFR 761.

KEYWORDS: PCBs; Polychlorinated Biphenyls; Disposal; Remediation; Cleaning; Ships

N04-101 TITLE: MW Class Near Infrared Optics

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Design, develop and demonstrate mirror coatings and substrates that will withstand the high irradiance and fluence associated with MW-Class Near Infrared (NIR) lasers.

BACKGROUND: The potential development of MW Class Laser Weapons (LW) requires that optical components withstand very large power densities without damage or causing distortion of the photon beam. Future Navy LWs will have to operate in a maritime environment, which dictates the wavelengths of interest are those that give relatively efficient beam transport through the atmosphere. The laser wavelengths of primary interest are in the near infrared (NIR), one to three-micron range (with 1.06 mm the nominal value). The Navy is currently considering both Free Electron Lasers (FELs) and appropriate wavelength Solid State Lasers (SSLs) as the photon sources. In order to make the optical train as compact and reliable as possible for the FELs, both the reflective and transmissive optics must be able to operate reliably when exposed to peak intensities of GW/cm2. Even with very high reflectivities the surfaces and substrates are required to dissipate substantial amounts of thermal energy without being either damaged or loss of optical beam quality. Furthermore, the optics will be illuminated by harmonics of the fundamental lasing frequency that will contain significant power. In addition, practical optics must be easy to handle and maintain in a warship/maritime environment.

DESCRIPTION: The Directed Energy Program Office is soliciting Small Business Innovative Research Proposals for the development for high average power, limited run time optics. Free Electron Lasers operating with output optical powers of multiple megawatts. This implies resonators cavity power levels that will be several times greater than this. Solid State Lasers with output powers of 500 kW or less are also being investigated. In each case the development of high flux optics and coatings (average >500 kW/cm2 incident) that can survive and maintain beam qualities of better than two-times diffraction limited are required. State of the art optics can tolerate average irradiances of 330 kW/cms.(2)

Although for the Navy missions of interest, the solid state lasers would be operated at the same wavelengths as the FELs, the FEL optics have some additional requirements. While the required average irradiance levels are typically about 500 kW/cm2, peak intensities associated with the micropulses can exceed GW/cm2. Furthermore, because of the femto-second pulse widths of the laser micro-pulses, the surfaces must accommodate a wavelength bandwidth of typically 3 nanometers. Fully conditioned FEL mirrors must operate with a vapor pressure of less than 10 -8 Torr.

PHASE I: Develop an engineering/physics model of the optical device that estimates the energy absorbed, transmitted and reflected energy, and predicts the time dependent temperature profiles of the heat flow. The model should also indicate how much, if any, the optical characteristics change with irradiation. Depending on the device design, the model may include only the optic itself, or if specialized cooling is requried the optic and the mounting fixture. The report shall include a description of the coating application methods, polishing procedures and techniques, and a description of the coating materials selection process (include the response of the materials to thermal shock and special bonding methods used). An evaluation of the model's performance under radiated conditions should be included, along with a description of how the element is mounted and aligned (including tolerances and how they are met). A description of maintenance procedures and an estimate of hardware lifetime under normal operating conditions shall be presented.

PHASE II: Utilize the results of the Phase I design to devise and construct a full-scale (in terms of average and peak intensities) physics demonstration of the required performance.

PHASE III: Integrate the design into the Navy's FEL Engineering Design Model (EDM) for concept of operation testing.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The general advantage to high power capable optics is that they can withstand the higher power densities (irradiance). This implies the overall system size can be made smaller; specifically because the resonator cavity can be made shorter. Commercial applications identified are: (1) Nanotube production, for a variety of applications such as transistors and diodes fabrication, flat panel display emitters, ion storage for batteries and material as strengthener. (2) Surface material processing (surface peening) to change surface characteristics to improve corrosion resistance. (3) Isotope separation to produce improved thermal conductivity in electronics chips.

REFERENCES:
1. DoD Master Plan Volume II, August 2, 2001. ODUSD (S&T()/WS LMP Vol-II, 22 September 2001.
2. John Taylor, et al.' SPIE VOL 1624 Page 1,, 1992.

KEYWORDS: Solid State Lasers, Free Electron Laser, anti-reflection coatings, reflective optics, transmissive optics

N04-102 TITLE: Undersea Cable Power Distribution Scheme

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Develop an electrical and optical power distribution scheme to support current commercial multi-fiber undersea cables designed to fit in current commercial pressure vessels as a "junction box" to house the required mechanical and electrical components. The distribution scheme should allow branches to be added to a high voltage multi fiber trunk, adding new power and data transmission demands. The "junction box" must provide fiber and power connectivity, as well as integrating the new data into the existing telemetry scheme.

DESCRIPTION: A low profile "junction box" located in the main cable run is desired to allow additional spurs to be added to the main trunk system. Current undersea commercial cable hardware limits power distribution schemes to simple "constant current" linear systems. Advances in cable technology allow for the design and production of pre-fabricated branching junctions. These junctions, providing power and optical fiber connectivity to an existing trunk line, allow for new spurs to be added to the main line. A power distribution scheme must be developed to handle existing and new non-linear load on the trunk system. Optical fiber connectivity can leverage previously developed telemetry integration technology to ensure new data is integrated into the trunk telemetry scheme.

The "junction box" design must contain electrical connections for remote power, fiber connections for optical data stream and capacity for telemetry integration cards. The design must allow for connectivity without redesigning and deploying new underwater hardware.

PHASE I: Develop a preliminary operational concept for an undersea cable electrical and optical power distribution scheme including the derivation of power supply and telemetry requirements to support the current system demands. The required electronic and optical components are expected to be housed in commercially available pressure vessels, therefore size is a key design consideration. Size limitations will be available on request.

PHASE II: Build and demonstrate an operational prototype of the undersea junction box power distribution system.

PHASE III: Integrate the undersea junction box power distribution system into the production program.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Technology for undersea junctions can be useful in any industry requiring the capability of expanding existing undersea telecommunication trunk lines. This power distribution concept could be adapted to support any optical data systems requiring system expansion without interrupting existing service.

KEYWORDS: Undersea; Fiber Optic; Junction; Telemetry; Power Supply; Cables

N04-103 TITLE: Advanced Antenna Integration Techniques

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

OBJECTIVE: Determine the feasibility of techniques to predict and minimize the surface wave excitation of platform structure caused by mounting antennas conformally or near the surface of platforms.

DESCRIPTION: Research is sought on the development and test of antenna techniques, which minimize the surface wave excitation of platforms structures caused by the mounting of antennas conformally or near the surface. Such antennas are intended to operate at the lower end of the microwave band and consist of elements of phased arrays. The antennas need to be thin and approximately conformal. High impedance surfaces are of particular interest. Desirable research efforts will produce antenna concepts with a minimal amount of degradation in the free space antenna patterns, and at the same time have characteristics, which have minimal effect on the operation of the platform. The investigation will make use of analytic techniques and experimental validation where appropriate. The result of the work will be techniques for the notional design of antennas, and experimental verification of reduced surface wave excitation. A theoretical analysis for the operation of the antenna must also be developed.

PHASE I: Develop techniques for the notional design of antennas, and experimental verification of reduced surface wave excitation. A theoretical analysis for the operation of the antenna must also be developed.

PHASE II: Design, construct, test and evaluate an antenna which incorporates the above features on a subscale platform.

PHASE III: Construct, integrate and test an antenna incorporating the proposed techniques on an objective platform

PRIVATE SECTOR COMMERCIAL POTENTIAL: The methods and techniques developed under this topic are intended for a specific military application. Thus, the commercial product into which these will be ultimately implemented consists of military electronic systems that would be developed, deployed and maintained by a defense prime contractor.

KEYWORDS: Antenna; Conformal Arrays; Surface wave excitation, Microwave

N04-104 TITLE: Advanced Waveform Synthesis for Active Sensors

NOTICE -- NOTICE -- NOTICE -- NOTICE -- NOTICE

Topic N04-104 has been cancelled

Proposals will not be accepted on this topic

N04-105 TITLE: Scalability analysis of autonomous intelligent networked systems

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: ACAT IVT: PEO (IWS)

OBJECTIVE: The objective of this project is to develop innovative technologies to demonstrate that distributed, intelligent networked systems can perform cooperatively in very large numbers. Such systems are being envisaged to satisfy Navy's future mission requirements in a mobile, reconfigurable environment. Such environments will be characterized by rapid changes in connectivity and the associated need to adaptively satisfy time-varying Quality-of-Service (QoS) requirements of a diverse set of applications. Such applications include data, voice, and video information that are typical of various command and control, situation awareness, and common operating picture applications.

DESCRIPTION: Infrastructure-less communication networks are being developed to establish a fully-mobile-reconfigurable communication network for intelligence, surveillance, reconnaissance, and strike support. Such applications require not only the exchange of data traffic, but also images as well as streaming video. Depending on the changing mission objectives and the interplay among different applications with time varying priorities, it is necessary to ensure that the communication networks provide the appropriate quality of service as the system is scaled. A number of protocols at various layers of the protocol stack are being developed for this purpose; these include QoS extensions to Medium Access Control (MAC) protocols, QoS-aware routing protocols in ad hoc networks for unicast and multicast traffic, as well as adaptive transport layer protocols. Although suggested protocols have been evaluated in isolation, there is lack of a methodology and associated tools to analyze and compare the performance of different solutions that have been proposed, particularly in systems that may include tens of thousands of heterogeneous communicating elements that include ground-, air-, and space-based assets.

PHASE I: Design architecture and methodology for a comparative evaluation of QoS protocols in a fully-mobile, dynamically reconfigurable network. Develop appropriate metrics to measure scalability properties of these protocols as well as applications and operational scenarios that include a diverse set of operating conditions. Identify the modeling and simulation tools that will be used to perform the analysis. The validation and verification approach that will be used must be developed.

PHASE II: Analyze the performance of QoS protocols at various layers of the protocol stack including MAC, network, and transport layers. The analysis must include terrain and weather effects, next generation radio technologies like Orthogonal Frequency Division Multiplexing (OFDM), must be scaled up to networks with tens of thousands of communicating element, and must include a protocol suite for controlling real-time dynamic multimedia communications networks and message trafficking via air, satellite, sea, and land-based nodes.

PHASE III: Implement the QoS management protocols that exhibit the best overall behavior in a commercially available operating system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Disaster recovery, homeland security, Fleet Management

REFERENCES:
1. Challenge: Integrating Mobile Wireless Devices Into the Computational Grid" Thomas Phan, Lloyd Huang, and Chris Dulan. In Proceedings of the 8th ACM International Conference on Mobile Computing and Networking (Mobicom 2002), September 2002.
2. "An Extensible and Scalable Content Adaptation Pipeline Architecture to Support Heterogeneous Clients," Thomas Phan, George Zorpas, and Rajive Bagrodia. In Proceedings of The 22nd International Conference on Distributed Computing Systems (ICDCS 2002), July 2-5, 2002.
3. "A Scalable, Distributed Middleware Service Architecture to Support Mobile Internet Applications," Thomas Phan, Richard Guy, and Rajive Bagrodia. Proceedings of the 1st ACM Workshop on Wireless Mobile Internet (WMI 2001) (a satellite workshop of Mobicom 2001), July 21, 2001, in Rome, Italy.

KEYWORDS: Multimedia; Communication; Mobile; Networks; scalability; Quality of Service

N04-106 TITLE: <u>Wide-Area Beam Steering for Simultaneous Laser Designation of Multiple Targets</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: ACAT IVT: PEO (IWS)

OBJECTIVE: Develop and demonstrate a single system capable of the simultaneous coded laser designation of several (greater than 4) small surface craft. Demonstrate acceptable performance against targets given suitably accurate track data.

DESCRIPTION: Currently fielded laser designation systems are capable of addressing only a single target at a time. A beam director, bore sighted to an imaging sensor (FLIR or visible TV), is used to track and paint a target with a Pulse Repetition Frequency (PRF) coded laser spot. This usually requires a man-in-the-loop for target acquisition and a significant transition time between targets to support sequential engagements. The changing battlespace requires the war fighter to engage multiple targets simultaneously instead of focusing on a single target at a time. Use of current designation systems to support parallel engagements requires multiple individual systems. Using several systems becomes resource and cost intensive, consequently, alternatives are required.

A scanning designation system capable of painting several different codes on multiple targets would decrease the time required per engagement, and allow multiple simultaneous engagements without target-weapon pairing problems. The scanning aperture would be required to cover all azimuthal angles. Variable elevation angles are required, with targets potentially separated by zero to several degrees in elevation and zero to 180 degrees in azimuth. This system must be compatible with current NATO standard PRF codes to avoid a requirement for unique munitions.

This designator will be attached and slaved to an advanced IR search and track (IRST) system, so required track accuracy for effective designation must be provided with the system design. Also, the beam director must be stabilized against ship motion. While laser target designation is the system's primary function, the unit must also provide range data on the designated targets. Multi-aperture or advanced optics concepts will also be considered.

PHASE I: Develop a conceptual design for a scanning Wide-Area Beam Steering Laser Designation System. The objective of this phase is to identify appropriate concepts and hardware configurations.

PHASE II: Finalize the design and fabricate a prototype multiple designation device. Demonstrate simultaneous coded designations with low jitter and sufficient steering agility.

PHASE III: Demonstrate the prototype against a minimum of 5 small surface craft targets in a sea environment, using a government supplied thermal imager as a surrogate IRST.
Coordinate with Government and industry to develop and test a system integrated with a government supplied IRST. Conduct an at-sea demonstration aboard ship.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Due to the rangefinding capability, this system has potential applications in surveying and navigation. In addition, there is a small potential entertainment market (laser light shows).

REFERENCE:
1. "Joint Laser Designation Procedures (JLASER)", Joint Pup 3-09.1, 1 June 1991.

KEYWORDS: Laser Designation, Beam Director, Rangefinder

N04-107 TITLE: <u>Real-time Multisensor Tracking and Correlation of Surface Targets</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO (IWS4.0)

OBJECTIVE: Develop an algorithm for performing target correlation and tracking for multiple, closely spaced surface targets. The algorithm should have the capability to integrate data from surface search sensors, including at a minimum, a surface search radar and Infrared Search and Track (IRST). Additionally, the algorithm should incorporate IR/Visible imagery data from an elevated platform such as a Unmanned Air Vehicle (UAV) or missile.

DESCRIPTION: Tracking of multiple closely spaced surface targets can be a difficult problem. Current systems in the fleet typically employ alpha-beta filtering or clustering approaches that operate on individual sensors. While representative of the state of the art at the time of their development, they are not representative of the performance that could be obtained from integrated approaches. Current asymmetric threat scenarios also place additional demands upon the surface tracking system, by requiring higher track accuracies, and better track correlation performance. While this problem has been examined at some length in the context of low-elevation air targets, there has been relatively little attention paid to the problem of surface targets. Furthermore, the application of Bayesian approaches to this problem could provide a ready framework for the incorporation of surface-constrained target motion, and behavior based dynamical target models. In general, the number of observable targets may, and frequently will be, different as observed by each sensor, both on the ship and on the elevated platform. This is due to multiple effects and sensor limitations such as wave masking of targets, masking of targets by nearer targets, multiple targets existing within a single radar range bin which are not resolved in azimuth, outlier targets that fall outside of the field of regard of the IR or video sensors on the ship or elevated platform, etc.

PHASE I: Develop an algorithm for surface tracking that incorporates data from an IRST, surface search radar, and IR or video imagery from an elevated platform. The algorithm should be able to work with data from any permutation of sensor data that could arise, given that data may not be available from all sensors at all times.

PHASE II: Demonstrate real-time performance of algorithm on representative Commercial-Off-The-Shelf platform.

PHASE III: Coordinate with Government and industry to develop an implementation plan including estimated cost to procure and incorporate the tracker into an existing sensor suite. Conduct an at-sea demonstration aboard ship.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Algorithms of this nature could be used in commercial ship navigation, especially in crowded ports.

REFERENCES:
1. A Tutorial on Particle Filters for On-line Non-Linear/Non-Gaussian Bayesian Tracking, Sanjeev Arulampalam, Simon Maskell, Neil Gordon, and Tim Clapp, IEEE Transactions on Acoustics, Speech and Signal Processing, Vol. 50(2), pages 174-188, February 2002.
2. Design of a real-time multisensor search and track system for the detection and tracking of low-flying anti-ship cruise missiles, Pawlak RJ, Horman SR, Stapleton R, Headley R. Proceedings American Society of Naval Engineers, March 1996.

KEYWORDS: Target Tracking, Multisensor Integration, Signal Processing

N04-108 TITLE: MIMO Techniques for LPI/LPD/AJ communications in highly mobile networks

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO (IWS)

LPI/LPD/AJ Techniques for Secure Mobile Wireless Communication Modems

OBJECTIVE: Develop the state of the art secure mobile wireless communication modem for LPD/LPI/AJ that is dynamically reconfigurable and have the ability to dial up different degrees of detection, intercept and jammer immunity. The concept to provide enhanced LPD/LPI/AJ characteristics by order of magnitude over currently available modem techniques.

DESCRIPTION: Conventional wireless communication systems set up a single link in a given frequency band. Consequently, any LPI/LPD/AJ protection based on traditional communication techniques comes at the cost of increased bandwidth and/or lower throughput. On the other hand, the highly connected digital battlefield of the future will have a tremendous appetite for high data rate communications.

Future combat radio systems require the ability to dramatically increase throughput rate without sacrificing bandwidth. To date, however, no work has been done on combat mobile systems to deliver superior LPI/LPD/AJ properties using existing or new waveforms.

The combat wireless systems must allow communications on different antennas at the same time and in the same frequency band. Consequently a new dimension, namely space, is added to the signaling space. In other words the systems should set up unique and independent spatial channels that can carry information simultaneously. This added spatial dimension can be exploited in modems to improve the covertness of the overall communication network or to improve its susceptibility to enemy jamming. This may requires new two-dimensional spread spectrum, or other, signaling techniques to exploit the added degree of freedom. The primary focus of this program, however, goes further than enhancing LPD/LPI/AJ characteristics over currently available modem techniques. The new signaling strategy and protocol must be designed specifically to meet the needs of the military's future autonomous intelligent networks that by nature are highly mobile. As a result all the underlying fabric of the communication infrastructure must allow for effortless reconfigurability of the system within a single platform. Backward compatibility with legacy spread spectrum systems is an important consideration in this program.

PHASE I: Conduct a feasibility study to identify and evaluate new spread spectrum or other techniques for LPI/LPD/AJ communications. The study should clearly contrast the potential benefits over conventional techniques. Identify state-of the-art modem architectures allowing a high level of flexibility to trade-off different degrees of detection, intercept and jammer immunity.

PHASE II: Design, develop, and refine the algorithms and strategies identified in Phase 1. Develop a testbed to showcase the impact of the developed algorithms and clearly demonstrate the enhanced LPI/LPD/AJ properties and flexibility of the new modem technology over traditional techniques.

PHASE III: Delivery of field ready units for testing in full scaled military trials.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Personal Communications Networks, Fleet Management, Emergency Services, Wireless Cellular.

REFERENCES:
1. R. Peterson, R. Ziemer, D. Borth, Introduction to Spread Spectrum Communications, Prentice Hall, 1995.
2. Theodore S. Rappaport, Wireless communications, principles & practice, Prentice Hall, 1996.
3. Foschini GJ, Gans MJ. Capacity when using diversity at transmit and receive sites and the Rayleigh-faded matrix channel is unknown at the transmitter. Sixth WINLAB Workshop on Third Generation Wireless Information Networks. Rutgers, State Univ. New Jersey. 1997, pp.217-27. Piscataway, NJ, USA.
4. Foschini GJ, Golden GD, Valenzuela RA, Wolniansky PW. Simplified processing for high spectral efficiency wireless communication employing multi-element arrays. [Journal Paper] IEEE Journal on Selected Areas in Communications, vol.17, no.11, Nov. 1999, pp.1841-52. Publisher: IEEE, USA
5. Huang H, Viswanathan H, Foschini GJ. Multiple antennas in cellular CDMA systems: transmission, detection, and spectral efficiency. IEEE Transactions on Wireless Communications, vol.1, no.3, July 2002, pp.383-92. Publisher: IEEE, USA

KEYWORDS: Multimedia; Communication; Mobile; Networks; ATM; Connectivity

N04-109 TITLE: MIMO-OFDM based communications for Autonomous Highly Mobile Networks

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO (IWS)

OBJECTIVE: The objective of this project is to develop Orthogonal Frequency Division Multiplexing (OFDM) based Multi Input Multi Output (MIMO) technologies to support a highly mobile network of autonomous intelligent agents. Such a system must ensure reliable communication of time-critical information in a robust jam-resistant communication networks whose members are continually in motion and whose member's rolls change over time. The communication system must be able to support a multitude of modalities (i.e. individual communicator, cluster head controller, back-bone communicator, etc.) on a single platform and must be able to intelligently adapt to changing requirements. At the radio level a large number of controls must be available to higher layer protocols to enable rapid reconfiguration of the physical layer in response to the needs of the higher layer protocols. The platform must easily fit into the requirements of the Autonomous Intelligent Networks and Systems (AINS) program, as such automatic learning and adaptation to environmental parameters is a key element of the work.

DESCRIPTION: A fully mobile reconfigurable communication network of autonomous agents consisting of Unmanned Air Vehicles (UGVs) and Unmanned Ground Vehicles (UGVs) must dynamically change its emissions profile and throughput to support varying types of traffic at different times. The radio element based on MIMO-OFDM technology is deemed to have tremendous potential for such applications. MIMO techniques have been demonstrated to increase system throughput by an order of magnitude compared to conventional radio communication techniques. Moreover they show great potential for dynamic reconfigurability and Low Probability of Intercept/Low Probability of Detection/Anti-Jamming (LPI/LPD/AJ) communication. OFDM techniques, on the other hand, have become the technique of choice for high-speed commercial wireless and wireline systems (ADSL, 802.11 Wireless LAN, Digital audio/video broadcasting). The adaptation of this technology for the military's autonomous intelligent networks of the future could deliver an unprecedented level of reliability and robustness that does not exist today.

PHASE I: Conduct a feasibility and tradeoff study that clearly demonstrates the performance and reliability of MIMO-OFDM communication in a host of military communication scenarios including urban warfare and homeland defense type settings. Investigate techniques and procedures for learning and adapting to changes in the communications environment and network topology.

PHASE II: Develop a stand alone testbed that can be used to validate the findings of the study in Phase I as well as to better understand the impact of this technology in a military setting. Further develop the MIMO OFDM communication system to incorporate support for modal (multi-mode) communications. Clearly demonstrate the ability of a single platform, or extensions of a single platform, to accommodate the diverse needs of the military's autonomous mobile networks of the future.

PHASE III: Commercialization of the testbed for military use. This includes form factor scaling and improving the robustness of the overall system. A reasonable number of the units will be required as part of this phase for testing in a scaled military network.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Personal Communications Networks, Fleet Management, Emergency Services, Wireless LAN.

REFERENCES:

1. G. G. Raleigh, J. M. Cioffi, "Spatio-Temporal Coding for Wireless Communication," IEEE Trans. on Communications, vol. 46, No. 3, pp. 357-366, March 1998.
2. Gerard J. Foschini, "Layered Space-Time Architecture for Wireless Communication in a Fading Environment When Using Multi-Element Antennas," Bell Labs Technical Journal, pp. 41-59, 1996.
3. Chuah C-N, Foschini GJ, Valenzuela RA, Chizhik D, Ling J, Kahn JM. Capacity growth of multi-element arrays in indoor and outdoor wireless channels," IEEE Wireless Communications and Networking Conference. Conference, vol.3, 2000, pp.1340-4 vol.3. Piscataway, NJ, USA
4. K. Pahlavan & A. H. Levesque "Wireless Information Networks", John Wiley and Son, 1995

KEYWORDS: Multimedia; Communication; Mobile; Networks; ATM; Connectivity

N04-110 TITLE: High Density Polymers for Reinforced High Density Reactive Materials

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO-TSC

OBJECTIVE: Enable the manufacture of an advanced reactive material (RM) which has increased strength to survive severe loading conditions.

DESCRIPTION: Currently, metal/polymer reactive fragments have low strength and only moderate densities. This weakness places limits on their use. This effort requires a design modification, which should increase strength and density of RM while not adversely affecting performance. The effort is directed toward the design, synthesis, characterization and preparation of high density polymers (organic, orgamometalic, or metal based) that can be processed via standard technologies (thermo set (temperatures below 150°C), thermo plastic, cast-cured, melt-cast). The new high density polymer systems must be capable of solid loads of up to 50% by volume and should have densities greater the 3g/cc for the polymer gunstock alone.

PHASE I: Demonstrate that reinforced reactive materials can be manufactured and that the tensile strength of the materials is improved by the inclusion of the reinforcement.

PHASE II: Demonstrate that the energetic performance is not substantially affected by the inclusion of the reinforcement.

PHASE III: Demonstrate that reinforced reactive material can be manufactured and/or machined into shapes with sufficient structure integrity to replace current plastic parts.

PRIVATE SECTOR COMMERCIAL POTENTIAL: High density polymer materials have application in commercial products were structural polymeric materials can economically replace structural metals. While current applications are limited to high energy output compositions directed toward weapons applications, it is anticipated that these new structural materials consisting of highly filled polymers will find application in the construction or automotive industries. Current weaker/less dense thermo-set filled plastic parts could be replaced by reinforced or filled high density polymer materials to increase strength and lifetime. The resultant cured systems will be more robust in their response to aging, ultraviolet light and temperature. The structural polymers market is in the hundreds of millions of pounds per year. Development of these high density polymeric materials represents a significant market potential.

REFERENCE:
1. Vavrick, D. J., "Injection Reaction Burn (IRB) Model", Proceedings Of 26th Annual Conference on Composites, Materials and Structures, Cape Canaveral, Florida, 27 January-2 February 2002.

KEYWORDS: High Density Polymers, Reinforced, Reactive, Energetic, Composite, Manufacture

N04-111 TITLE: Synthesis of Energetic PrePolymers of Varying BAMO and NMMO or PGN Content and Structure

TECHNOLOGY AREAS: Weapons

OBJECTIVE: The problem here is a lack of sufficient quantities and types of azido containing polymers required for initial evaluation of polymer gum-stock formation via a triazole cure reaction. At a 5.0 to 10.0% level of azido containing polymers in a 500-gm propellant mix, the reaction can consume up to 50-gms of material during initial formulation development. At this point, such materials have been synthesized only on the gram scale in the laboratory and the property characteristics of the polymer structure not fully explored. New synthesis methodologies and small quantities of various azido containing polymers (approximately 25 gram samples) are needed.

BACKGROUND: Cast-curable oligomers, which include most of the binder materials used for propellants and explosives, are typically cured into rubbery materials by the reaction of a di- or polyisocyanate with the hydroxyl groups at the end of the oligomeric chains. This reaction allows the mixing of energetic oxidizers, fuels and other filler materials into a castable mixture without the evolution of water or gaseous byproducts and the solidification of the mixture into the shape of choice. The facility of the reaction, its absence of byproducts, and the vast array of chemical structures available in both the hydroxy-terminated binder material and the di- and polyisocyanate curing agents, ensure that a combination of oligomer and curative can easily be found that will impart satisfactory mechanical properties to the binder. The ceaseless search for higher performance in explosives and propellants has necessitated the investigation of new energetic ingredients whose chemistry is inimical to the urethane cure reaction. An effort has begun to explore the curing of azido-terminated oligomers with di- or polyacetylenes to form triazole rings linking the oligomers into a polymer network as a means of finding a more robust polymer cure mechanism which is not sensitive to the reactivity of these new energetic ingredients. Thus far, it has been shown that this cure, like the isocyanate/hydroxyl reaction, is facile, evolves no water or gaseous byproducts, and, in addition, proceeds in the presence of energetic compounds, which absolutely prevent the curing of isocyanate/hydroxyl binder mixtures.

DESCRIPTION: Develop synthetic procedures and prepare sufficient quantities (minimum 25 gram samples) of azido containing polymers to elucidate the structure/concentration-activity relationships and mechanical properties resulting from curing by the formation of triazole linkages. Polymers should consist of mixtures of 3,3'-bis(azidomethyl) oxetane (BAMO) with either 3-nitratomethyl-3-methyl oxetane (NMMO) or poly-nitratomethyl oxirane (PGN) [AKA-- Polyglycidylnitrate (Poly-GLYN)] units, but other suitable polymer ingredients will be considered.

DESCRIPTION: Develop synthesis methods that allow for the systematic variation in the design and nature of azido-oligomers mixtures containing 3,3'-bis(azidomethyl) oxetane co-polymerized with either 3-nitratomethyl-3-methyloxetane (BAMO/NMMO) or poly-nitratomethyl oxirane (BAMO/PGN). Characterize these materials with regard to structural composition and polymer properties to ensure co-polymerization of monomer units in the concentrations suggested.

Initial efforts should focus on methods to end-cap low molecular weight NMMO and PGN oligomers (2000-4000 MW range) with BAMO units. Subsequent efforts should focus on the synthesis of BAMO/NMMO or BAMO/PGN samples ranging in concentration from 5/95 to 40/60. Within these ratios, the following polymer types should be examined:

1) Random Co-Polymer Structure--BAMO units randomly distributed as single mer units throughout the NMMO or PGN matrix.
2) Random and Blocked Co-Polymer Structure--BAMO units randomly distributed in the NMMO or PGN, but as short-chain clusters of ...--(BAMO-BAMO-BAMO)x--... along the much more lengthy NMMO or PGN chains .
3) Blocked Co-Polymer Structure--BAMO units concentrated on the ends of full-length NMMO or PGN chains.

Fundamental analysis and polymer characterization data is necessary during Phase I and should include NMR, viscosity, polymer-functionality and dispersity determinations.

PHASE I: Synthesis of 25-gm quantities of representative BAMO and NMMO or PGN co-polymers described above, characterization and analysis, and delivery to government laboratories for evaluation.

PHASE II: Scaleup of the successful composition(s) to pound quantities for larger-scale evaluation and process research and development effort to define mini-pilot plant design (2000 pounds/year scale).

PHASE III: Transition technology to next generation propulsion and ordnance systems. Provide costing and data package for pilot plan production of materials based on requirements and need. Examples include next generation RAM, Sidewinder, and AMRAM missile propulsion systems and new underwater explosive compositions for 6.25 torpedo system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The cures of hydroxy-terminated conventional rubbers and binder materials should, in principle, be affected by the triazole linkage if the hydroxy end-groups were substituted with azide moieties. This would render unnecessary the use of the relatively toxic isocyanate compounds that are currently used as curatives, lowering the hazards involved in fabrication. The resultant triazole-cured rubbers may be more robust in their response to aging, ultraviolet light and temperature. The urethane/isocyanate cure market is in the hundreds of millions of pounds per year. This represents a significant potential market.

KEYWORDS: acetylene; azide; triazole; crosslink; binder; PGN; BAMO; NMMO; polymerization.

N04-112 TITLE: <u>Sub-Pixel Super-Resolution ATR</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO IWS3C

OBJECTIVE: To develop passive (Electro-Optical (EO), Infrared (IR)) and active (Tera-Hertz (THZ), Radio-Frequency (RF)) sensor fusion that enables sub-pixel super-resolution in surveillance image processing with an increased standoff distance beyond current Aided/Automatic Target Recognition (ATR) capability in rainy, foggy and nighttime severe weather conditions against terrorist or other asymmetric enemy forces

DESCRIPTION: Technologies that offer passive spectrum and active spectrum sensor fusion and registration are maturing. Smart algorithms such as the Gerchberg-Saxon-Poupolis super-resolution algorithm [5] have been generalized to include unsupervised learning and classification by means of artificial neural networks (ANN).

On the other hand, defense priorities demand that Naval forces be given advance warning of a terrorist or other asymmetric enemy attacks: e.g. in-port surveillance systems for ships, over-the-horizon littoral warfare, tactical intelligence capabilities for Marines engaged in urban-littoral combat, sea-based intelligence capabilities that support Operational Maneuver from the Sea [1,2,3].

All of these operational demands require advanced passive-active sensor fusion and un-biased-unsupervised ATR models that support all meteorological and oceanographic forecasting and nowcasting in the maritime battlespaces. The proposed effort based on both the passive EO-IR and the active THZ-RF should enhance the ability of Naval forces to anticipate, prepare for, recognize, survive, and retaliate against a terrorist or other asymmetric attack. Approaches that offer passive, active, or a combination of both in addressing enhanced sub-pixel resolution and ATR capabilities will be considered. The proposed effort should be available within two years.

PHASE I: Develop an innovative concept for passive, cost-effective, and uncooled EO-IR multi-spectral sensors, and demonstrate fusion design incorporating both active & passive spectrum integration that promises a significant standoff capability against terrorism and other asymmetric threats.

PHASE II: Prove the concept by delivering a working prototype of the fusion of EO-IR with THZ-RF spectrum technology to enhance the resolution.

PHASE III: Conduct a full laboratory feasibility test & evaluation for potential transition to advanced development guided by the aforementioned transition sponsors and commercial production package for health care surveillance systems.

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PRIVATE SECTOR COMMERCIAL POTENTIAL: Technologies developed in response to this desired capability offer multiple opportunities for commercial surveillance exploitation; hot-spot detection could be useful for early tumor identification [5] through time-dependent, angiogenesis-induced spectrum change.

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5. “Wavelet Transform of Super-resolutions based on Radar and Infrared sensor Fusion” Navy patent No. 5,952,957, Sept. 14, 1999 Gerchberg-Saxton Poupulus super-resolution via bi-orthogonal dual projection is implemented by wavelet transform viewpoint for localized wideband transients SNR enhancement.
6. "Multispectral Infrared Images Fusion for Breast Imaging," Navy Case Number 83,801 (2002)

N04-113 TITLE: Optimization Techniques for High Performance Vacuum Electronic Devices

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO (IWS)

OBJECTIVE: To identify and develop algorithms pertaining to the optimization of traveling-wave tubes (TWTs), including (but not limited to) optimization techniques for efficient numerical computation and design techniques that achieve an optimal point design subject to practical issues such as cost and manufacturing constraints. Successful algorithms will be subsequently integrated with existing physics-based simulation codes, such as the large-signal helix TWT code CHRISTINE and the 2-/3-D gun/collector code MICHELLE.

DESCRIPTION: The focus of the development is twofold. First, the effort will concentrate on implementation of modern statistical optimization methods for meeting a set of performance specifications while maximizing permitted manufacturing tolerances, thereby increasing manufacturing yield and reducing the cost of the TWT. Second, to achieve the level of accuracy necessary to achieve first-pass design success, many devices require fine-scale details to be resolved on conformal meshes. Current Automatic Mesh Refinement (AMR) algorithms only consider field errors, which have proven to be insufficient for beam simulations. Therefore, the beam effects must be factored into AMR algorithms to meet the simulation accuracy and efficiency needs for electrostatic particle-in-cell models.

PHASE I: Design the visualization tactics to provide an efficient, user-friendly interface between the physics-based codes (e.g., CHRISTINE and MICHELLE) and the optimization algorithms. Select optimization algorithms that will be suitable to the optimization of TWT circuit designs, minimizing the sensitivity to mechanical tolerances, minimizing the effects of uncertainties in the dielectric properties of dielectric support rods, and subject to a maximum allowed thermal dissipation due to helix current flow. Choose a method for field/beam simulations that will optimize the use of memory, run time, and time steps by optimizing the mesh in a way that the minimum number of elements is used to model a gun or collector.

PHASE II: Develop an optimization methodology or set of methodologies that effectively utilize the visualization techniques and graphical user interfaces developed in Phase I. Demonstrate the improved optimization algorithms using the large-signal code CHRISTINE and the gun/collector code MICHELLE. Access to the both codes will be provided to the program at no cost.

PHASE III: Transition to commercial markets and non-SBIR funded status through the sale of the optimization software to private corporations and/or government entities who are in the business of developing high performance products that meet performance requirements such as lifetime specifications while minimizing the sensitivity to parameter uncertainties. This may include TWT's for EW and high data rate communication.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Commercial applications of the optimization methodology include the development of high performance products, which require optimization techniques in order to meet stringent performance requirements, including device lifetime, while simultaneously minimizing sensitivity to parameter tolerances.

KEYWORDS: optimization, TWT, adaptive mesh generation, electron gun, TWT efficiency

N04-114 TITLE: Thermal Management Leads

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO (IWS)

OBJECTIVE: To demonstrate and develop advanced electrical lead concepts that will allow systems with components at substantially different operating temperatures to be packaged in close proximity. This will ensure that system size and weight are minimized and power efficiency maximized. Such leads are required in systems utilizing either superconductive digital electronics (4-10K) in close proximity to room temperature components or wide band gap semiconductor power amplifiers („d150C) attached to room temperature radiating elements. The leads will enable the software-defined Radio Frequency (RF) systems, especially those with array geometries that are required for Joint Vision 2020.

DESCRIPTION: Superconducting digital electronics offers the inherent accuracy and high clock speeds required to enable RF systems to perform multiple functionalities simultaneously and via software parameter selection. However, they also require cooling to ca. 4K to function and the power efficiency of refrigerators at these temperatures is low. The heat load is currently dominated by the essential power input and signal I/O electrical leads and must be reduced. Power amplifiers must be in good electrical contact with the antennas, but also must not warm them despite the fact that amplifiers typically dissipate as heat more power than they radiate. In homogeneous materials, electrical and thermal conductivity scale together. A material structure that breaks this relationship is needed. It is presumed that an innovative composite structure is required so that distinct physical behaviors can be combined.

PHASE I: Develop an innovative lead concept already as described in the proposal, and evaluate its trade-off of thermal and electrical conductivity, experimentally and by simulation, over an appropriate temperature range.

PHASE II: Demonstrate significant reduction compared to conventional packaging technology in the heat load on the colder thermal stage connected by the lead under realistic, single RF channel lead operation.

PHASE III: Transition into software defined RF systems such as the Joint Tactical Radio System or RF active arrays.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The electrical power industry is very interested in being able to utilize high temperature superconducting (HTS) conductors to transport energy with low loss. However, for short transport distances, the extra heat load on the coolers coming from the transitions to and from the HTS cable offsets the majority of the energy savings. Thus, they require this product; as well as, the wireless telecom industry for implementation of the HTS RF filters. With such leads attached to any hot running electrical part, the waste heat is contained within that part until intentionally removed. These leads should thus also simplify thermal management issues for laptop computers and improve the efficiency of thermoelectric coolers.

KEYWORDS: thermal management; conductivity; phonons; entropy transport; heat flow; interface resistance

N04-115 TITLE: <u>Adaptive, Intelligent Acoustic Recognition/Alert Systems for Security Breaching Noise Detection, Close Proximity Danger Identification, and Perimeter Protection</u>

TECHNOLOGY AREAS: Sensors

ACQUISITION PROGRAM: IVT-Tactical Remote Sensor Systems and DASN – Littoral and Mine Warfare

OBJECTIVE: To design and demonstrate the use of sound recognition technology for the detection, classification, and localization of potential security breaching noises in the context of high-noise environments, i.e., when signal-to-noise ratios (SNRs) are 0db or less, such as military installations, ships, and vehicles.

DESCRIPTION: Current acoustic sensor technology is limited in terms of its field-deployability because (i) accuracy degrades considerably in the context of real-world, noisy conditions, (ii) target classification of sensor output requires considerable post-processing, and (iii) sensors and post-processing analyses generally are designed for a limited target set. The Navy is looking for intelligent acoustic sensor systems that can be trained to recognize a broad range, including subsets, of discrete sounds. The desired system needs to perform with at least a 90% accuracy rate in the context of a variety of multiple background noises, and when total environmental noise is approximately equivalent to the energy of the target signal (i.e., 0db SNR). Since military assets and facilities vary in terms of their environmental setting (background noises), and in terms the class of potential threats (target sounds of interest), different sounds must be recognized in the context of different backgrounds. Therefore, the technology must be trainable and intelligent. Once a target sound is detected, the smart sensors need to collaborate together and in conjunction with other types of sensors (sensor fusion) to determine the location, speed of movement (when applicable), relevance (direction), and number of sources of each distinct target sound. This effort would demonstrate detection and recognition of sound amidst potential battlefield noise, urban environments, such as house to house searches, and any other environment where other types of sensors cannot discriminate threats.

PHASE I: Test the feasibility of technology to recognize discrete sound at +xxDb at least 90% of the time. Also test the feasibility of the technology to recognize discrete sound at less than +20db 80% of the time.

PHASE II: Create a prototype of an acoustic recognition array with the capabilities described in Phase 1 but scaled for large scale operation similar to a military installation or Naval Base.

PHASE III: Implement acoustic recognition as an integral component of government facilities and anti-terrorist protection.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology has broad applications for vehicular and home security applications, especially for homes and vehicles adjacent to noisy streets. By listening for the sounds typical of an intruder, early warning with minimal false positives can be generated.

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KEYWORDS: acoustics; sensors; neural networks; temporal pattern recognition; homeland security

N04-116 TITLE: <u>Cross-Cultural Tactical Decision-Making in Coalition Operations</u>

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PMW 157 Global Command and Control Support System – Maritime (GCCS-M)

OBJECTIVE: Develop a quick response, collaborative, cross-cultural intelligence analysis capability for processing uncertain tactical data produced as a component of asymmetric and coalition-based warfare. Address the problem by combining extant intelligent web-based open-source information retrieval technology with peer-to-peer collaborative information delivery systems that leverages or computationally models cognitive processes employed in human information processing.

DESCRIPTION: Defense transformation is responding to the increasing probability of continued asymmetric warfare. With this new wartime environment has come the need to respond to complex, multi-cultural intelligence analysis demands. Characteristics of this new environment include: distributed decision making; operations with coalition, non-government and volunteer organizations; reliance on open-source data; rapidly changing team members; culturally diverse partners; and more human interface with agents/automated systems. The new environment presents a formidable challenge for the retrieval, fusion and presentation of intelligence information, especially in view of increased uncertainty of source data. The capability to get the right information to the right people at the right time will increasingly depend on information processing which can leverage the cognitive processing of humans. The capability to provide knowledge interoperability among diverse participants/teams could be provided by combining cognitive information processing principles with available low bandwidth, peer-to-peer collaboration tools and advanced information retrieval technology. These enabling communication technologies would be applied to existing knowledge object management tools to accomplish representation and transfer of meaning or intent among mixed-discipline collaborating teams.

PHASE I: Develop and validate a cognitive-process based model for multidisciplinary teams engaged in information processing of diverse forms of open-source data for the purpose of reducing uncertainty in predicting threats, trends and crises. Use available information retrieval technology to sort, fuse and graphically present information in a low bandwidth, web-based environment for collaborative development of common situational awareness. Propose metrics to assess team shared understanding and team performance.

PHASE II: Conduct one or more field experiments to validate the model and demonstrate its benefit in improved team intelligence analysis. Incorporate a capability for a visualization-at-a-glance assessment of the impact of data uncertainty.

PHASE III: Incorporate a prototype module in a planned operational test environment at PACOM's HQ21 installation or a fleet battle experiment and collect metrics to demonstrate operational effectiveness of the system. Optional target could be HQ 21, a war room environment or a corporate commercial intelligence gathering site.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private-sector applications would include corporate-level marketing or investment decision-making in competitive environments.

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KEYWORDS: Collaborative; Intelligence; Multi-cultural; Web-based; Open-source; Information technology

N04-117 TITLE: Marine Mammal Vaccines

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: PEO-LMW/PMS-EOD; MK4, MK5, MK6, MK7 & MK 8 MOD MARINE MAMMAL SYSTEMs (MMS)

OBJECTIVE: Develop protective DNA vaccines for Navy's marine mammal fleet support systems, demonstrate vaccine safety, and prove efficacy through pathogen challenge studies with a non-marine mammal/non-primate animal model.

DESCRIPTION: The Navy's Fleet Marine Mammal Systems (MMS) perform vital missions in support of countermine operations, perimeter protection, and human swimmer defense. The MMS may be deployed or may train in areas where MM infectious diseases exist in wild populations, thus MMS animals may be exposed and could potentially contract an infection. Preventive medicine and minimization of illness among the deployed animals (as well as the Navy's breeding animals) is a priority for maintaining peak readiness of this critical Navy capability. Preliminary research results suggest DNA vaccines may be a safe approach to MM immunization, and plasmid vaccines to protect the dolphin (Tursiops truncatus) against dolphin morbillivirus (DMV) have been developed under an ONR-funded research program. The efficacy of these vaccine candidates is unknown; as pathogen challenge studies to assess the protective effects of DNA (or other) vaccines cannot be undertaken in MM for ethical reasons. What are required are studies to assess prophylactic efficacy of and to optimize DNA plasmid vaccines in a non-marine mammal animal model. The selected animal model should be susceptible to the MM pathogen(s) of interest [e.g., DMV]. DMV, Erisipylothrix, and Brucella have been identified by the Navy through a formal risk assessment process as being the pathogens of greatest concern to the MMS.

PHASE I: Design and test endotoxin-free DNA vaccines targeted for a dolphin pathogen (e.g., DMV) for protection against challenge in a vertebrate animal model which is not a marine mammal or primate. Utilize existing, published immunobiology reagents to document cellular/humoral immune responses in the model animal. Demonstration of a protective effect in the selected animal model would be required to proceed to Phase II. Note that DOD vertebrate animal use protocols must be completed by successful applicant – these are available at: http://www.onr.navy.mil/sci_tech/personnel/docs/animal_instruct.doc.

PHASE II: Explore various DNA vaccine administration strategies – e.g., varying routes of administration (IM, IV, oral, nasal), dosage, and prime-boost strategies to optimize DNA vaccine efficacy in a non-marine mammal/non-primate animal model. Develop and test additional immunobiology reagents (e.g., antibodies, antigens, genetic probes) as needed to validate vaccine efficacy in the model animal as well as the dolphin.

PHASE III: If proven safe and effective, prepare vaccine in bulk for use by Navy's fleet MMS for inoculation of its deployed and breeding animals. In addition, U.S. NOAA Fisheries Office of Protective Resources has indicated that if a safe and effective vaccine were available it would contemplate purchase for prophylaxis of select, wild MM populations at risk of infection, and potentially stranded animals as well.

PRIVATE SECTOR COMMERCIAL POTENTIAL: It is anticipated that the market for MM DNA vaccines would include owners of captive MM's (aquaria, theme parks, university research facilities) as well as MMS operated by allied defense agencies. The Alliance of Marine Mammal Parks and Aquariums (AMMPA) currently lists 36 organizational members (www.aampa.org) and is aware of >200 facilities worldwide that possess captive marine mammal. A Congressional Research Service Report (1997, 97-517ENR) indicates that in 1997, approximately 109 facilities were in operation in North America, and that these possessed 1450 marine mammals. AMMPA believes the current number of animals is approximately 2000. The market is significantly expanded if one includes other exotic captive animals – DNA vaccine technology has been investigated experimentally in fowl, ruminants, fish, and other classes of animals, and information gained through the current topic may be generally applicable.

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KEYWORDS: DNA vaccine; marine mammal; dolphin; sea lion; immunobiology; morbillivirus

N04-118 TITLE: Agent-based Simulation of Shipboard Manpower & Personnel (M&P) Behaviors

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PERS-4, N-13

OBJECTIVE: The objective of this effort is to investigate the applicability of an agent-based simulation approach based on Complex Adaptive Systems concepts to the content area of manpower and personnel (M&P).

DESCRIPTION: Agent-based simulations appear to be useful tools for examining behavior in various complex social systems including energy markets, airline cargo operations, and financial markets. This effort would investigate the applicability of agent-based simulation to a new domain, the manpower and personnel system of the United States Navy. The effort would start with a single Navy ship and, over time, build to a Navy battlegroup. The effort would investigate both the personnel flows aboard Navy ships and the ability of agent-based simulation to replicate those real-world flows. Developing software agents of Navy personnel would allow M&P analysts to investigate how manning Navy ships with crews that differ in behavioral characteristics impact Navy readiness. It would also give Navy M&P analysts a tool to model impacts of changes in M&P policies at the ship/battlegroup level, a tool that does not currently exist.

PHASE I: Provide a feasibility concept study on the applicability of agent-based simulation on the manpower and personnel system of the Navy

PHASE II: Develop, test, and verify an agent-based simulation depicting M&P behaviors aboard a single Navy ship.

PHASE III: Expand the initial single ship agent-based simulation to the M&P behaviors of a Navy battle group. Provide the developed agent-based simulation to Navy M&P analysts, along with relevant documentation and orientation.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be adapted to any large organization interested in analyzing personnel behaviors and their impact on organizational performance.

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KEYWORDS: Agents; personnel; simulation; modeling; shipboard; automation

N04-119 TITLE: Automated Communication Analysis for Interactive Situation Awareness Assessment

TECHNOLOGY AREAS: Human Systems

ACQUISITION PROGRAM: PMW 157 Global Command and Control Support System – Maritime (GCCS-M)

OBJECTIVE: Validate and demonstrate the application of automated communication data analysis techniques to the real time assessment of team situational awareness and team performance in tactical decision-making or intelligence analysis.

DESCRIPTION: National Defense Transformation from platform-based warfare to quick-response asymmetric warfare has driven the requirement for fully-netted situational awareness in future operations described as unique, one-of-a-kind actions requiring quick response on high impact issues. Operations will be distributed, have quickly changing participants, uncertain data/intelligence and more automated and agent-based interfaces. Some examples of capabilities required to respond to this new environment include:

Quick development of shared understanding among participants
Quick analysis of uncertain and open source data
Human friendly and cognitive process leveraging agents
Collaboration facilitating tools with performance metrics

Team shared understanding is central to many tasks faced by the military in which multiple operators who are separated by space and time interact to make time-critical decisions in a complex data-uncertain environment. Communication provides a data set that can quantify team cognition and the collaborative thought that underlies team performance. New discourse analysis techniques have been developed that can be used to analyze the patterns and content of communication data for understanding how teams visualize and fuse information into a shared understanding. These techniques include communication sequential flow analysis and Latent Semantic Analysis. Correlations between the resulting communication patterns and other team-level measures can be exploited to measure team performance, team cognition and team situational awareness. The results of these findings will have implications for the design of tools for knowledge visualization and management of team collaboration networks. They may be used to exploit communication data for on-line real-time performance assessment and diagnosis in a host of applied settings including the assessment of teams in combat information centers air-defense systems, and remote battlefield command, control, communications, and intelligence (C3I) centers.

PHASE I: Identify, assess and validate existing communication data analysis tools (such as sequential analysis, flow techniques, Latent Semantic Analysis, etc) that quantify the content and patterns of information flow in team collaborative activity. Show that these tools can link communication content and flow patterns to team situational awareness and team performance. Incorporate these tools into a computational model or automated agent to enable the collection of real-time data to measure and improve team situational awareness.

PHASE II: Develop a prototype, based on empirically validated techniques and evaluate in a simulated or representative operational environment. Provide metrics and measures to assure the extensibility of the prototype to other operational venues.

PHASE III: Validate, standardize and document underlying software for application purposes and implement in a field experiment. Coordinate with user subject matter experts to instantiate a working model with actual data, get user commitment for training and maintenance of the application. Collect performance data to validate improved performance. The proposed communication analysis tools could be applied in command and control activities, intelligence analysis and corporate level business strategy development.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology product could be applied to any collaborative or team problem solving situation where it is necessary to develop a team consensus on an issue or product.

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KEYWORDS: Communication, analysis, situational awareness, problem solving

N04-120 TITLE: Portable, lightweight, amalgamated thin-film photovoltaic/battery combination

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: IVT; Expeditionary Power Systems

OBJECTIVE: The purpose of this effort is to amalgamate thin-film photovoltaic solar-electric energy conversion with modern thin-film battery technology to create a self-contained, rechargeable package.

DESCRIPTION: Over the past several decades, considerable progress has been made in the separate technologies of solar thin-film photovoltaic energy conversion and thin-film battery systems. There is a clear utility in having a combined system that could both provide power and self-charge during daylight hours while continuing to provide electric power via battery discharge in darkness. There is an even greater utility in having an amalgamated system whose dual use would be automatic and transparent to the user. Such a system would be used to power a wide variety of portable electronic equipment such as two-way radios, Global Positioning System (GPS), computers, and a variety of other devices.

PHASE I: The objective of Phase I is to demonstrate conclusively that these two thin-film technologies can be combined and will function by providing both (D.C.) electric power via solar energy conversion and battery-charging in daylight and electric power via battery discharge in darkness. The combined package should yield 50 Watts power at 28 volts in either the photovoltaic/charging or battery-only modes. The battery should fully recharge in cloudy daylight in 6 hours.

PHASE II: It is expected that in Phase II a portable, contained (i.e., reasonable-sized), and operational system will be developed and demonstrated powering actual devices such as two-way radios that would normally be powered by conventional batteries. The size of the unit ideally would be one that can be incorporated into a standard uniform: approximately 0.5 square meter. Increased power needs should be demonstrated by simple up-scaling of the surface area of the unit.

PHASE III: Upon successful demonstration in Phases I & II, an amalgamated photovoltaic/thin-film battery unit should be designed and ready for manufacture for use in several clearly identified electrically powered units.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is growing interest in the use of photovoltaic materials for powering electrical equipment, particularly automated sensing and communication equipment located in remote regions. A particular example application is the powering of remote, automated weather forecasting and reporting stations located at unmanned airports. Night operation applications mandate the need for an amalgamated battery.

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KEYWORDS: photovoltaic, battery, thin-film, hybrid system, rechargeable, automated

N04-121 TITLE: Large-Scale Batch Manufacture of Solid Polymer Electrolytes for High Energy and Power Density Rechargeable Li and Li-Ion Batteries

TECHNOLOGY AREAS: Electronics

ACQUISITION PROGRAM: IVT; Marine Corps Expeditionary Power Sources

OBJECTIVE: Demonstrate practical manufacturing techniques for the economic preparation of solid polymer electrolytes in sufficient quantities to support evaluation in large rechargeable batteries.

DESCRIPTION: Adequate power and energy sources continue to be a vital unmet need for many Naval missions, particularly those that require compact, lightweight, low signature (acoustic, thermal, and magnetic) power. Current primary and rechargeable battery technologies used by the Fleet to meet those requirements impose a significant logistics burden. Advanced rechargeable lithium and lithium-ion batteries are anticipated to reduce the weight of batteries for Marine Expeditionary units and to provide enhanced endurance for Navy Special Operations Forces undersea vehicles. The Navy and Marine Corps have supported the development of solid polymer electrolytes to maximize the power and energy density of these rechargeable batteries.1-4 Solid polymer electrolytes provide improved performance by reducing the amount of inactive material in the battery and are inherently light-weight. Safety is also enhanced since these polymer electrolytes are entirely solid-state, eliminating the presence of flammable organic solvents. Recent progress has demonstrated that solid-state electrolytes with lithium transference numbers near 1 can perform comparably to their liquid counterparts in small cells.1 These materials are stable in air, soluble in common organic solvents, and can be prepared using a scalable synthetic process. The development and optimization of manufacturing techniques for reproducible batch synthesis of these solid polymer electrolytes is required to provide sufficient material for evaluation as thin film electrolytes in large batteries. Production of large, thin sheets of electrolyte is also desirable.

PHASE I: Practical manufacturing techniques to produce large, reproducible batches of solid polymer electrolyte that retain the lithium transference number and battery performance characteristics demonstrated in small cells need to be developed. Phase I projects should provide a feasibility demonstration of the proposed approach to synthesize multi-kg batches of solid polymer electrolyte that is air-stable, soluble in common organic solvents, and easy to handle. Retention of the lithium transference number for the material(s) produced should be validated.

PHASE II: Batch processing of several multi-kg batches and reproducibility of a high lithium transference number between batches should be demonstrated. The ability to cast large sheets (at least 3”x5”) of the polymer electrolyte with some mechanical integrity should be demonstrated. Multi-kg quantities of solid polymer electrolyte material should be available at the completion of the program for evaluation in large battery geometries by either a Navy lab or commercial battery company.

PHASE III: The solid polymer electrolyte materials produced should be transitioned to a conventional or thin-film battery company capable of producing rechargeable lithium and/or lithium-ion batteries.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Millions of lithium-ion batteries are produced each month for the commercial portable electronics equipment industry. The introduction of solid polymer electrolytes to these batteries would reduce the weight and increase the run time of laptops, cell phones, and PDAs.

REFERENCES:

1. P. E. Trapa, B. Huang, Y.-Y. Won, D. R. Sadoway, and A. M. Mayes, Electrochem. & Sol. State Letters 5(5), PP. A85-A88 (2002).
2. B. Huang, C. C. Cook, S. Mui, P. P. Soo, D. H. Staelin, A. M. Mayes, D. R. Sadoway, J. Power Sources 97-98, pp. 674-676 (2001).
3. A.-V. G. Ruzette, P. P. Soo, D. R. Sadoway, and A. M. Mayes, J. Electrochem. Soc. 148(6), pp. A537-A543 (2001).
4. D. R. Sadoway, B. Huang, P. E. Trapa, P. P. Soo, P. Bannerjee, and A. M. Mayes, J. Power Sources 97-98, pp. 621-623 (2001).

KEYWORDS: batteries, power sources, solid polymer electrolyte, lithium-polymer battery

N04-122 TITLE: Microbubble Injector and Measurement System

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: The friction drag of ships can be reduced by injecting air bubbles into the water adjacent to the hull but it hasn't yet been found how to do it at an efficiency that makes it worthwhile. The objective here is the design of an injection system of microbubble swarms and an instrument that can characterize the bubble population in a small volume.

DESCRIPTION: Interest is focused on free-stream speeds of about 35 ms-1. Assuming that, and assuming a smooth hull, the water in the layer immediately adjacent to the hull (the viscous sub-layer) is moving at a speed, u_V, given, roughly, by $u_V \approx 1.1y$, where y is the distance from the hull measured in microns and u_V is in ms^{-1}. The thickness of the viscous sub-layer is about 10 microns. The next layer, the buffer layer, will be assumed to be 150 microns thick; it is characterized by a logarithmic speed dependency; $u_L \approx 5.8 + 6.1log_{10}(y)$. It is known that drag reduction is effected by bubbles only if they are small, and only if they are in the buffer layer. "Small" will be assumed to be 10 microns in diameter. A 10 micron bubble exiting a source on the surface of the hull will experience a drag force that accelerates it in the direction of the water flow, and, because of the flow shear, it will also experience a Magnus-like normal force that accelerates it toward the buffer layer. The shear is less in the buffer layer, and the speed in the flow direction acquired by the bubble will further diminish the Magnus force, so small bubbles will tend to remain in the buffer layer.

A robust system is needed to inject 10-micron bubbles into the buffer layer in a manner that allows the fraction of the layer's volume occupied by the bubbles to be controlled over the range from about 25% to as close as possible to the close-packed maximum of 74%. Two of the obvious problems that have to be overcome are; the speed at the midline of the buffer layer is about three times that at the midline of the viscous sub-layer, so a bubble stream injected into the sub layer will "accordion" out to an occupancy of roughly 30% coalescence of the bubbles has to be avoided

In addition to a bubble injection system, a robust measurement system is also needed that could characterize the bubble population at a number of point-like volumes downstream of the injection area. "Characterize" is intended to mean a three-dimensional picture, a tomographic representation, and "point-like" is intended to mean a cubic volume of about one or two millimeters on a side extending down to the hull surface.

PHASE I: Devise an injector system and produce a quantitative analytic description of its performance characteristics, that can be implemented in the form of a strip flush with the hull surface and transverse to the flow and which, must satisfy the following goals which are, for ease of exposition only, expressed as though the implementation were in the form of parallel lines of orifices; control the diameter of the bubbles to be 10 ± 1 microns space the orifices along each line in such a way as to maximize the lateral packing factor without risk of coalescence space the lines, and control and synchronize the emission instants, to maximize the longitudinal packing factor without risk of coalescence

Devise an instrument capable of performing the measurement described above and produce a quantitative analytic description of its performance characteristics. It would be desirable if the measurement could be made without having to penetrate the flow but, recognizing the virtual impossibility of achieving that, the next-best solution would be to employ a retractable apparatus that, in its withdrawn condition leaves the water-hull surface smooth. What's needed is the ability to count the bubble population at different distances from the hull within the buffer layer, and to check on coalescence occurrences. It is believed that a spatial resolution of a few microns is required in each of the three spatial dimensions.

PHASE II: Construct prototypes of a bubble injection and a bubble population measurement system and demonstrate their properties in a (small) water tunnel.

PHASE III: It is expected that a successful result will be implemented in a large-scale high-speed measurement program aimed at fully characterizing the merits of microbubble-induced friction drag reduction. If that measurement program should show convincing advantages to this technique, it is expected that the injector would see wide application on ships.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Instruments of this sort would find wide use in many manufacturing operations. The utility of drag reduction is appealing to commercial shipping as a means of reducing fuel costs.

KEYWORDS: microbubble drag reduction

N04-123 TITLE: Quiet, Efficient, High Power-Density Integrated Motor/Propulsor (IMP) and Controller

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS 450, PMS 403; DD(X),

OBJECTIVE: Develop and demonstrate a quiet and efficient advanced Integrated Motor/Propulsor (IMP) and Controller concept that provides higher power density than existing commercial and naval motors. Innovations in design, materials selection, and manufacturing technique will be essential. The IMP and controller should meet the following notional design and performance requirements at a minimum:

Notional Design and Performance Requirements:

Motor output: ~50 HP (37 kW),
Power Density ≥ 1 kW/kg (0.6 HP/lb)
Bearing capable of long-life operation in seawater,
Final design suitable for a wet test either in a pump loop or in a water tunnel.

DESCRIPTION: The U.S. Navy is currently developing technologies for all electric ships and submarines. One of the major challenges for all electric naval ships/submarines is the development of high power-density motor/propulsor that is quiet and efficient. A potential solution for this challenge is an integrated motor/propulsor (IMP) concept. The IMP is envisioned as an enabler for significantly reduced cost and increased payload fraction for submarines and Unmanned Underwater Vehicles (UUV).

PHASE I: Develop an innovative design of an IMP concept, power electronics and controller, including material selection that would meet the notional Design and Performance Requirements described above at a minimum. Carry out performance prediction/assessment using analytical/numerical and/or empirical methods. Performance would include motor/controller system efficiency and impeller hydrodynamic efficiency. Document the design and performance analyses.

PHASE II: Fabricate an IMP and controller and power electronics based on the design developed in Phase I; demonstrate the performance that would characterize the motor/controller system efficiency, quietness, and durability in in-water environment through a land-based and a pump-loop or a water-tunnel experiments.

PHASE III: Develop a commercialization strategy and plan for applications for commercial and military vessels, together with a full-scale application strategy.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology has a great potential for an advanced propulsion system for commercial and military ships, submarines, UUVs, Autonomous Undesea Vehicles (AUVs), and Advanced Seal Delivery System (ASDS).

REFERENCES:
1. Electric-Drive Propulsion for U.S. Navy Ships: Background and Issues for Congress, CRS Report for Congress by Ronald O'Rourke(July 31, 2000)
2. Submarine Integrated Power System Report (Electric Boat, 2001)
3. "Virginia Class, Integrated Power System Architecture Section - KAPL, Bettis, and BPMI Concurrence with Comment and Recommendation for NAVSEA Approval (U)" KAPL Letter ARP-68B30-0144,Oct 24, 2001

KEYWORDS: electric motor, permanent magnet motor, integrated motor/pump, underwater vehicle propulsor, electric drive

N04-124 TITLE: Joining Methodologies for Titanium Alloys

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Space Platforms

ACQUISITION PROGRAM: PEO(S), PEO(C)

OBJECTIVE: Explore and develop affordable, environmentally sound methodologies for joining large sections of titanium alloys with good mechanical properties.

DESCRIPTION: Corrosion-resistant, high-strength, light-weight near-alpha titanium alloys have long been desirable for structural applications because of their reliability and positive impact on maintenance and total ownership cost reduction. However, the cost of processed titanium has prohibited its use in large structures. Current efforts to develop low cost production methodologies for the reduction of titanium metal are addressing this issue and have spurred renewed interest in the potential of titanium alloys for construction of large structures including aircraft, ground vehicles, ships and submarines.

Exploitation of titanium for large-scale applications is severely limited by the inability to provide cost-effective joining of plate and wrought materials. Among the technical challenges to be overcome are those associated with the process, e.g.

- close control of interstitial-element contamination,
- understanding and control of microstructural evolution and the effects on mechanical properties during joining, and
- design of filler metal and weld parameters for cost-effective, clean weldments.

Additional or alternative approaches may include optimization of the pre-welded workpiece microstructure for weldability

- through alloy development and/or
- by thermomechanical processing.

Strong proposals will demonstrate the offerors' thorough knowledge of the issues unique to joining titanium alloys, especially for those alloys of particular interest to the naval community which include, but are not limited to, Timetal 5111, Ti-3Al-2.5V and commercially pure titanium. Innovative approaches that address the limitations of past efforts and apply application new knowledge/understanding are encouraged. Particular emphasis is placed on demonstrating that the joining methodology minimizes the amount of interstitial element contamination (final O<1000ppm, N<100ppm and H<100ppm). Mechanical properties of interest are directly related to control of the weld and heat affected zone microstructures and prevention of hard particle inclusions. The resultant fracture toughness, stress corrosion cracking resistance and fatigue strength should be comparable to those of the based metal. Cost effectiveness is expected to be a function of welding time per linear foot, alloy and filler metal composition, requirements for shielding gas and power input, and required operator skill level.

PHASE I: Develop and demonstrate the feasibility of an innovative methodology for enhancing the cost effectiveness and final properties of titanium alloy joints. Show that chemistry and microstructure can be adequately controlled so that the goals for interstitial content and mechanical properties are feasible.

PHASE II: Demonstrate the effectiveness of the innovation for affordability and desired properties of the joined material. Specifically, reproducibility should be demonstrated and a processing window that will meet chemical, microstructural and mechanical property requirements should be described. A realistic assessment of implementation costs should be developed.

PHASE III: Develop pilot-scale systems for implementing the innovation.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This methodology will have potential application for the construction of civilian air, sea, and rail transportation.

KEYWORDS: affordability; titanium alloys; weldability; composition; microstructure control; thermomechanical processing

N04-125 TITLE: High Power Density and Thermally Stable Capacitors for Power Electronics Applications

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes

ACQUISITION PROGRAM: IVT DD(X) and CVN-21

OBJECTIVE: Devise and fabricate practical high power density and thermally stable capacitors for Navy, DOD and civilian applications to reduce the size and weight of shipboard and hybrid electric vehicle power electronics.

DESCRIPTION: The Navy and DOD are increasingly reliant on electricity to operate rail guns and other new weapons, electromagnetic launchers and sensors, and to propel hybrid automotive electric vehicles and ships. Military systems incorporate solid state power electronics to perform functions such as AC to DC or DC to AC power conversion. Current generation power electronics are larger, heavier, more expensive and less efficient than desired. Little research has been done in recent years to improve dielectric materials for high energy density, good thermal stability and high break down field. The allowable operating temperature of power electronics devices is expected to increase; the passive components will become the limiting factor in thermal design. Smaller, lighter, more efficient and more thermally tolerant capacitors and inductors will enable a significant overall improvement in future power electronics systems, enabling new Naval capability. Goals for capacitors and inductors include 70 % reduction in volume and weight, losses reduced to < 1 %, and the capability to operate at temperatures in excess of 200O C.

PHASE I: Design and show the feasibility of the proposed technology at the laboratory scale. Perform engineering studies to show the potential benefit for a chosen application.

PHASE II: Refine the design and show the performance enhancements of the proposed technology at full scale.

PHASE III: Demonstrate the cost-effective manufacturability of the targeted device structure in quantities appropriate to defense and civilian markets.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Applications over a wide range of military and commercial power applications, both for industrial and shipboard power conversion and hybrid automotive electric vehicles.

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1. W. J. Sarjeant, I. W. Clelland and R. A. Price, "Capacitive Components for Power Electronics," Proceedings of the IEEE, 89, 6, June 2001.
2. Future Naval Capabilities Website: http://www.onr.navy.mil/sci_tecxh/futurenaval.htm

KEYWORDS: Capacitors. Power electronics, energy densities, thermal stability

N04-126 TITLE: Dynamical Control of a Thermal Pulse Combustor

TECHNOLOGY AREAS: Air Platform

ACQUISITION PROGRAM: IVT : NAVAIR PMA 264: Air Anti-Submarine Warfare

OBJECTIVE: Understand nonlinear dynamical oscillations and instabilities in a thermal pulse combustor. Design, build, and successfully operate a control system in a thermal pulse combustor to prevent flameout in a jet engine under a variety of operational conditions.

DESCRIPTION: Thermal pulse combustors can exhibit complex dynamical behaviors including instabilities leading to jet engine flameout. Being able to predict when the combustion dynamics has entered a dangerous region leading to flameout is the first step towards designing a control mechanism to prevent flameout. A calculated and applied fast response to alter the combustion dynamics to prevent flameout is the goal of this research. Success in this program might also enable engine operation at leaner fuel mixtures to improve fuel economy.

PHASE I: Construct, instrument, and operate a thermal combustor and thoroughly analyze its dynamical temperature and pressure oscillations for a variety of fuel mixtures and flow rates. Determine precursors in the dynamics signaling the onset of flameout.

PHASE II: Design and implement a control mechanism that can identify the precursors to flameout and have the ability to rapidly modify aspects of the combustor dynamics to prevent flameout. Demonstrate the ability of the controlled thermal pulse combustor to prevent flameout under a variety of operating conditions and to increase fuel economy and reduce emissions.

PHASE III: Modify a thermal combustor in a jet engine to test the prevention of flameout under operating conditions that otherwise lead to an eventual flameout.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology may be applied to increase the efficiency and to reduce emissions in jet engines, and in commercial power generation.

REFERENCES:
1. Experimental Maintenance of Chaos, Visarath In, et. al. Phys. Rev. Lett. 74, 4420 (1995).
2. Maintenance of Chaos in a Computational Model of a Thermal Pulse Combustor, Visarath In, et. al. Chaos 7, 605 (1997).
3. Controlling and Maintaining Chaos in High Dimensions, Visarath In, et. al. Proceedings of the 4th Experimental Chaos Conference, (World Scientific, Singapore, 1998), p. 257.
4. Maintaining Chaos in High Dimensions, Visarath In, et. al.Phys. Rev. Lett. 80, 700 (1998).

KEYWORDS: thermal combustor, jet engine, chaos control, flameout, power generation, nonlinear dynamics

N04-127 TITLE: Automated Launch and Recovery of Un-tethered, Mini-Unmanned Underwater Vehicles from Unmanned Surface Vehicles

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS501

OBJECTIVE: To develop a system for automated launch, recovery and recharging of small, un-tethered Unmanned Underwater Vehicles (UUVs) that are deployed from Unmanned Surface Vehicles (USVs).

DESCRIPTION: Unmanned Surface Vehicles of length 20' – 35' are being considered by the US Navy for mine-hunting operations. It is possible for a USV to be able to carry one or more, un-tethered mini-UUVs into an operational area. The mini-UUVs might then be equipped with applicable sonars to perform mine-hunting operations. The USV would be capable of autonomously launching and recovering the small UUVs as well as providing the capability to charge batteries, download sonar data to the USV and upload new mission parameters from the USV. This concept requires the development of a common UUV launch and recovery (L&R) system on-board the USV. The small UUVs will weigh 75-150 lbs and be 6"-21" in diameter and 4'-10' long. The REMUS is an example of such a UUV. The system proposed should be capable of launching, recovering and recharging up to 4 UUVs from a USV. A critical aspect of the system will be its autonomous operation. This approach has the benefit of providing longer time-on-station to the UUV since its battery power would not need to be used to transit to the operational area and the USV would be available to recharge the UUV's batteries.

PHASE I: Demonstrate the feasibility of an automated system that will be installed on a USV (in Phase III) and will provide launch and recovery of a variety of small UUVs, recharge the UUVs' batteries and provide a data interface between USV and UUV, including, download of sensor data from UUV to USV and upload of new mission parameters from USV to UUV.

PHASE II: Fabricate a prototype system developed in Phase I. Through laboratory testing, validate the properties of the system as defined in Phase I.

PHASE III: Install and demonstrate prototype system fabricated in Phase II on a USV. Provide at-sea demonstration of ability of prototype system to launch, recover, recharge and provide data interface to a small UUV from a USV. Provide detailed drawings and specifications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Small boat-builders and machinery automation industries will benefit from this topic. Commercial applications include use on oceanographic survey vessels, off-shore oil exploration and salvage ships.

REFERENCES:
1. "SPARTAN Unmanned Surface Vehicle Extends the USW Battlespace-SPARTAN Concept", Naval Forces, Special Issue 2001, p. 18.
2. UUV Master Plan: A Vision for Navy Development, Barbara Fletcher, SPAWAR http://www.spawar.navy.mil/robots/pubs/oceans2000b.pdf

KEYWORDS: USV; UUV; Launch; Recovery; Minehunting; Automation

N04-128 TITLE: Unmanned Surface Vehicle Autonomous Maritime Seaway Navigation

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PMS501

OBJECTIVE: To develop an active, motion/position sensing and/or forward-looking control system to assist a USV in navigating accurately through waves efficiently and on course without experiencing excessive motions or capsizing.

DESCRIPTION: In the future, it is expected that the U.S. Navy will utilize unmanned surface vehicles (USVs) to perform various missions. These USVs will have to transit over some distance to reach their mission area, and then perform additional maneuvering or stationkeeping while executing the mission. This will require an autonomous system on-board the USV to assist the craft in navigating through waves optimizing course and speed to maximize fuel efficiency.

PHASE I: Develop a detailed design concept/approach and specification for a USV automated seaway navigation system. The design and specification will include a wave detection/characterization capability such as collision avoidance radar, and then processing of the radar imagery to determine USV course and speed in order to optimize navigation and stationkeeping. Alternatively, the system might use motion detection and prediction to characterize waves in a seaway, and then use the resulting information to maintain its station or optimize navigation by setting correct speed and course.

PHASE II: Develop and test a prototype USV automated seaway navigation system based on the design concept/approach and specification developed in Phase I.

PHASE III: Install and test control system on a small surface craft. Provide detailed drawings and specifications. Transition to PMS501.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private industry will benefit by producing the automated seaway navigation systems for many types of unmanned surface vehicles supporting many maritime industrial areas including; oceanographic survey vessels, off-shore oil exploration and salvage ships, shipping industry, Coast Guard and the Border Patrol.

REFERENCES:
1. "SPARTAN Unmanned Surface Vehicle Extends the USW Battlespace-SPARTAN Concept", Naval Forces, Special Issue 2001, p. 18.

KEYWORDS: unmanned surface vehicle, automated seaway navigation

N04-129 TITLE: Near-Wall Turbulence and Skin Friction Measurements

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Enable measurements of steady and unsteady turbulence in the proximity of walls/surfaces at high Reynolds numbers and provide a self-contained skin-friction measurement gauge capability.

DESCRIPTION: At high Reynolds number conditions (10 to 1000 million), the important turbulent flow quantities (mean and instantaneous velocities) reside within 10s of microns from the wall. No current system can measure quantities with sufficient accuracy to gain an understanding of the flow (e.g., 3D pressure gradient effects, or wall roughness effects, etc) or to measure the wall skin friction. For design, the resistance is a key component in arriving at a viable propulsion system. For example, the friction drag of ships can, at least in principle, be reduced by the use of some form of lubrication at the hull-water interface. Efforts to explore that possibility are hindered by, inter alia, the lack of a means of making direct measurements of friction drag at points on the hull's surface. The objective here is to provide a means to understand the near-wall turbulence and to design a gauge that will remedy this deficiency. A somewhat simplified description of the problem is as follows: Assume a free-stream velocities of 35 ms-1 (with a smooth hull), the water in the layer immediately adjacent to the hull (the viscous sub-layer) is moving at a speed, u_V, given, roughly, by $u_V \approx 1.1y$, where y is the distance from the hull measured in microns and u_V is in ms^{-1} , where y is the distance from the hull measured in microns and u_V is in ms-1. The shear force imposed on a smooth hull is about 1000 Pa. A capability is needed that can measure the near-wall flow velocities and the stresses directly on the wall. The shear stress device should be flush with the hull.

PHASE I: Proof of concept demonstration with variations in Reynolds numbers (as high as 1 million) in a water channel/tunnel for a near-wall turbulence measurement system. For the shear-stress device, the contractor is expected to devise an instrument, and to produce a quantitative analytic description of its performance characteristics, that can be implemented in the form of an insert whose outer surface is flush with the hull and is of approximate dimensions 25 mm in length and 12 mm in width. It must be watertight, and able to withstand pressures of as much as 10 atmospheres. There must be no moving parts except for the strain needed to produce a change in the physical property used to effect the sensing. It is expected that the accuracy would be ± 1% or better and that the output would be a digitized sampled data stream.

PHASE II: For near-wall measurements, the contractor will develop and demonstrate the turbulence measurement system at high Reynolds numbers (10 million) on a flat plate in a water tunnel/channel and compare results with analytical theory of turbulence, providing mean and unsteady velocities to within 2-5 microns of the surface. For the shear-stress device, the contractor is expected to construct a prototype and demonstrate its properties in a (small) water tunnel.

PHASE III: For the near-wall measurement system, the contractor will prepare complete system and user-documentation. For the shear-stress device, it is expected that a successful result will be implemented in a large-scale high-speed measurement program aimed at fully characterizing the merits of various techniques of friction drag reduction.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Turbulent and resistance measurement systems are useful to both air and underwater application communities. This system would provide the unique capability for the commercial and military aircraft, submarine, and ship industries.

KEYWORDS: turbulence; hydromechanics; underwater measurements; diagnostics; drag reduction; wall roughness; shear stress

N04-130 TITLE: Advanced Portable Multi-Laser Processing System.

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: To develop a portable multi-wavelength laser processing system capable of cleaning, cutting, joining, polishing, cladding and also capable of producing unique surface coatings with ultra-hard and ultra-tough characteristics. The system should include control system(s), articulating mechanics, the beam delivery and optical components and be capable to processing an area of at least 1 cm2. The system should include up to three laser wavelengths ranging in frequencies from the UV to the IR but should be capable of accommodating more wavelengths in the future.

DESCRIPTION: There is a need to develop new processing and synthesis technologies that can quickly, reliably and economically process the surface of a substrate material and deposit new layers of identical or different composition on its surface. The ultimate goal of a system of this nature can be multiple. For instance one could use such a system to reclaim expensive parts back into service by resurfacing old components that have experienced wear, corrosion or other forms of surface degradation. One could also use such a system to enhance the performance and/or life of critical components by modifying the surface through phase transformations or by adding high performance surface coatings. Recent work using a multi-wavelength laser system has shown the capability of achieving such multiple tasks.

Recent multi-laser processing experimental work indicates that such a laser system could be made flexible enough to simultaneously combine various materials processing and synthesis functions into one simple and portable unit. Multi-wavelength processing allows for the simultaneous control of pressure, temperature and chemical reactivity allowing for the formation of unique coatings. Some of these coatings could be applied to gears and bearings to reduce friction and wear; to valves and fittings to reduce corrosion and galling; to windows and transparencies to improve rain-drop and sand erosion resistance; to metallic rails to improve life.

PHASE I: During Phase I of the program the PI will develop a single or multi-wavelength laser system, including the beam delivery and optical components, capable of modifying the surface microstructure of a steel substrates so as to change its hardness by 10%. The PI will also develop a plan and an approach for a development of a portable multi-wavelength material processing laser.

PHASE II: During the Phase II of the program the PI will develop a complete prototype portable multi-laser processing system. The system will include up to at least three wavelengths ranging in frequencies from the UV to the IR, feedstock delivery system and gas delivery system. The PI will demonstrate the capability of the system to clean, cut, join, polish and clad a steel substrate. Finally the PI will also demonstrate the capability of producing unique surface coatings with hard and tough characteristics.

PHASE III: A system of this nature could be used to enhance the mechanical properties in many DoD components (such as gears, bearings, valves, turbines, disks, windows) used in ships, submarines, aircraft, missiles since they all have critical components that would benefit from extra life by the application of hard and tough surface coatings. Significant cost savings could be achieved by extending the life and reducing the maintenance of these systems. Seek, via interaction with the technical points of contact and with other engineers at NAVSEA and NSWC, transition opportunities in to ships and submarines.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The ability to reclaim expensive part back into service and of extending the life of critical components can be directly applied not only to military components, but also to commercial components. The potential in the commercial sector is significantly larger than the military sector.

REFERENCES:
1. R. Roy, A. Badzian, E. Breval, P. Mistry, M. Turchan, “Simultaneous multiple pulsed laser induced transformations in ZrO_2 ceramics,” J. of Mat. Chem. 2000, 10, 2236-3337

KEYWORDS: Laser Processing, Laser Synthesis, Hard Coatings, Multi-Laser Processing

N04-131 TITLE: Detectability of Low Radar Cross-Section (RCS) Targets at Sea

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO SHIPS(PMS 500 – DDX)

OBJECTIVE: Produce a first-principles, analytical model that can accurately (within 10% of probability or range) predict the detectability of small to medium size (10 m to 100 m long and 2 m to 20 m tall) targets with low RCS on the ocean surface.

DESCRIPTION: Several empirically-based radar prediction codes have been used to estimate the detectability of small ships and craft on the ocean surface. However, the predictions produced by these codes often do not match real-life experience. A better code is needed in order to support the requirements-definition and design of new ships. This code could be useful to the Navy, Coast Guard, and Marines.

This code could also be applied to estimate the detectability of adversary targets by U.S. ships. Law enforcement agencies could use this code to estimate the detection of violators using small ships or craft.

It is anticipated that work performed during and beyond Phase I will require the small business to possess a SECRET security clearance.

PHASE I: Develop a system design for a small ship RCS detectability code. This should identify all of the relevant factors, a design of the code, the required accuracy of the code’s elements, and an approach for verification and validation.

PHASE II: Build and verify the small ship RCS detectability code.

PHASE III: Validate the code. Participate with Navy agencies in the application of the code to Navy problems. Provide the Code to Navy agencies with training.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This code could be used in a variety of applications. It could be applied to safety of navigation, collision avoidance, fishing vessel safety, recreational vessel safety, and search and rescue.

REFERENCES:
1. Merrill Skolnik, ”Radar Handbook”, 2nd Ed, McGraw Hill Professional; June 1990
2. David K. Barton, ”Modern Radar Systems Analysis”, Artech House Radar Library; June 1988
3. Eugene Knott, John Schaeffer, Michael Tuley, “Radar Cross Section”, 2nd Ed; Artech House, 1993

KEYWORDS: radar, detection, marine, clutter, attenuation, statistics

N04-132 TITLE: Energy Finite Element Analysis System

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: PEO SHIPS(PMS 500 – DDX)

OBJECTIVE: Improve the accuracy and analysis process for naval designs through the development of advanced energy analysis software. This technique will allow engineers to assess signature reduction for new Navy initiatives, and to meet potential future requirements for machinery, flow, and propulsion related noise. The energy analysis approach will also support interior noise reduction improvements for both steady state (machinery) and transient (aircraft) in crew living and working spaces. Finally, the new simulation capability will support analysis of the high frequency vibration environment induced on electronic equipment due to shock loads.

DESCRIPTION: Energy Finite Element Analysis (EFEA) has been employed for computing noise radiated from underwater vehicles as a result of flow excitation. Results have been compared favorably to test data. The EFEA technology is very promising in analyzing full scale naval structures for acoustic signature, habitability, and shock considerations. This effort supports proposals for using this technology to build a general simulation system for surface ships and submarines.

PHASE I: Identify and extend EFEA formulation techniques for submarines and surface ship platforms. Develop approaches to account for partial fluid loading on the structure, mixed phase materials and for the free surface effects on the acoustic radiation.

PHASE II: Develop and test an EFEA system for modeling a hull structure with a large number of internal compartments. This is necessary in order to model a full scale surface ship or submarine. Matrix partitioning techniques and parallel solver technology will be incorporated into the EFEA system. A user-friendly procedure for configuring the joints between a large number of compartments and partitions will also be developed and tested.

PHASE III: Prepare a user-friendly software package with technical manuals that can be used by engineers in the naval, automotive, and aerospace industries. Identify techniques for integration of this package with standard navy ship design software products.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The end product will be used in the areas of noise and vibration and in shock isolation by engineers in the automotive, aerospace, and naval industries.

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2. W. Zhang, A. Wang, and N. Vlahopoulos, “An Alternative Energy Finite Element Formulation based on Incoherent Orthogonal Waves and its Validation for Marine Structures,” Finite Elements in Analysis and Design, Vol.38, 2002, pp. 1095-1113.

KEYWORDS: vibration, acoustics, naval structures, signatures, habitability, energy finite element analysis

N04-133 TITLE: Infrared/Electro-Optic Detectability of Small Targets at Sea

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Produce a first-principles, analytical model that can accurately (within 10% of probability or range) predict the infrared and electro-optic detectability of small to medium size (10 m to 100 m long and 2 m to 20 m tall) targets on the ocean surface.

DESCRIPTION: Several empirically-based infrared and electro-optic prediction codes have been used to estimate the detectability of small ships and craft on the ocean surface. However, most of these are adapted from codes designed for detection of land targets and are based on technology developed in WWII. The predictions produced by these codes often do not match real-life experience. A better code is needed in order to support the requirements-definition and design of new ships. It is important that this code interface with Navy infrared and electro-optic scene generators. This code could be useful to the Navy, Coast Guard, and Marines.

This code could also be applied to estimate the detectability of adversary targets by U.S. ships. Law enforcement agencies could use this code to estimate the detection of violators using small ships or craft.

It is anticipated that work performed during and beyond Phase I will require the small business to possess a SECRET security clearance

PHASE I: Develop a system design for a small ship IR-EO detectability code. This should identify all of the relevant factors, a design of the code, the required accuracy of the code's elements, and an approach for verification and validation.

PHASE II: Build and verify the small ship IR-EO detectability code.

PHASE III: Validate the code. Participate with Navy agencies in the application of the code to Navy problems. Provide the Code to Navy agencies with training.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This code could be used in a variety of applications. It could be applied to safety of navigation, collision avoidance, fishing vessel safety, recreational vessel safety, and search and rescue.

REFERENCES:

1. George J. Zissis, ed; William Wolfe, ed., "Infrared Handbook", Erim International, June 1985

KEYWORDS: infrared, electro-optics, detection, marine, clutter, attenuation

N04-134 TITLE: Recovery Algorithms for Ship Survivability

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: Develop a set of algorithms that predict how well ship systems can recover after damage to or failure of key components during combat operations.

DESCRIPTION: Several Navy Science and Technology programs are pursuing and evaluating substantial design changes in the configuration and operation of shipboard engineering plant systems. These changes are designed to ensure rapid response of shipboard systems to operational requirements and to react to damage, failure or other stress conditions, particularly during battle. Such designs depend on rapid sensing of the condition of engineering plant systems; quick, automatic response and reconfiguration to mitigate effects of damage or failure; and accurate prediction of the post damage/failure condition of the affected systems along with the operational capability of the platform. These sensing, response and prediction abilities will be crucial to platform survivability and fight-through capability.

Tools currently available can determine the extent of damage or failure immediately after it occurs. Available tools also can assess the progression of such damage or failure. However, the ability to assess how quickly and completely ship systems can recover from damage or failure will be a key factor in the assessment of operational capabilities and might be a major driver in the design and configuration of a ship and its systems.

These factors dictate the need for more comprehensive and responsive recoverability algorithms to predict ship and subsystem post damage/failure capability. Such algorithms would ideally define necessary mission performance contributions made by ship auxiliary and electrical systems, how mission performance degrades with damage to any system, how reconfiguration of the system after damage restores capability, the degree of restoration that can be achieved, and the time required for that restoration of capability. This is an extremely complex, time dependent issue involving the functional and geometric relationship of numerous systems within a ship.

PHASE I: Develop sample recovery algorithms focused on limited shipboard engineering plant systems and demonstrate the feasibility of using these algorithms to predict the post damage/failure state of these systems.

PHASE II: Develop recovery algorithms for a specific set of engineering plant systems, integrate these algorithms with current tools that determine the extent and progression of damage or failure, and demonstrate the capability of the integrated system to effectively predict post damage or failure system capability.

PHASE III: Partner or otherwise interface with other organizations in the implementation of distributed control systems for automated survivability, which will include the recovery algorithms as part of the distributed control package

PRIVATE SECTOR COMMERCIAL POTENTIAL: This system could be applied to any distributed control system application in commercial vessels, commercial vehicles, or utility distribution systems.

KEYWORDS: Automation, algorithms, distributed control systems, damage and failure recovery prediction, survivability, fight-through

N04-135 TITLE: Nano-Catalytic Combustion for Compact High-Thrust to Weight Ratio Propulsion Systems

TECHNOLOGY AREAS: Weapons

OBJECTIVE: To synthesize, and/or produce, characterize, and test nanoscale metallic fuel/catalyst materials for use in conjunction with a more conventional hydrocarbon fuel, to accomplish in-situ participating catalytic combustion.

DESCRIPTION: Catalytic combustion reduced emission of automobiles. Metals used as the catalytic surfaces initiate reactions, with greatly reduced activation energy for bond breaking. However in-chamber catalytic combustion takes away combustor space (use of catalytic surfaces), and large particles, eroded off from the catalytic metal surfaces, deposit on and erode downstream components, such as turbine blades. Moreover large (micron-size) particles do not mix well with the combustion gas stream, due to their large inertia, and thus combustion efficiency is reduced. Nanocatalysts, mixed with the fuel, or directly injected, could eliminate these problems. Oxides of aluminum exhibit catalytic properties at higher temperatures (as opposed to noble & expensive metals used in low-temperature post-combustion catalytic converters). Assume a nanometal particle, encapsulated within an oxide coating, and introduced along with the fuel; the outer coating will act as a catalyst until its melting point is reached; the metal fuel encapsulated will be combusted, together with the shell coating, itself. This will greatly add to the energy release, if the metal used in the catalyst is an energetic fuel such as aluminum or boron. Doping the particle with materials, such as magnesium, will ease combustion initiation.

PHASE I: Synthesize small quantities of hybrid fuel comprising of nanoscale metallic fuel/catalyst materials that will exhibit in-situ participating catalytic combustion to be used in conjunction with conventional fuels.

PHASE II: Produce sufficient quantities of this nanohybrid fuel, study its rheology and characterize its burning properties – oxidation chemistry, reaction pathways, energy release rate, and emission characteristics.

PHASE III: Prepare large quantities of fuel, and demonstrate nanocatalytic combustion in combustors of practical geometry. Design of pilot plants to produce the fuel.

PRIVATE SECTOR COMMERCIAL POTENTIAL: These fuels can be utilized in industry/commercial combustion as well – engines for auxiliary power generation in ships, compact engines for back-up generators.

KEYWORDS: Hybrid fuels, catalysis, energy release, nanoparticles, metal combustion, and fuel synthesis

N04-136 TITLE: Adaptive Control of High-Speed Supercavitating Bodies

TECHNOLOGY AREAS: Weapons

ACQUISITION PROGRAM: Undersea Defensive Warfare Systems (Submarine and Surface Ship)

OBJECTIVE: Develop vehicle control devices and associated control algorithms for high-speed supercavitating bodies. Specifically, the control devices include adaptive cavitator, control surfaces such as fins, and thrust vectoring propulsion systems.

DESCRIPTION: A vehicle traveling underwater, at very high speed, creates a gaseous cavity (supercavitating bubble) around it. Because the solid surface in contact with water is significantly reduced, this leads to significant reduction in drag, and hence the vehicle is capable to attain ultra-high speed well over 100 meters per second. Such supercavitating vehicles, including torpedoes and gun-launched projectiles, are expected to offer the Navy tactical advantage for Anti Submarine Warfare (ASW) and Anti Surface Warfare (ASuW) close encounter scenarios. However, controlling the motion of such vehicles requires adaptive control devices and an intelligent controller to control the supercavitating bubble and the dynamics of the vehicle, such as tail slapping. The control devices include adaptive cavitator, control surfaces such as fins, and thrust vector propulsion systems. Robust control techniques, open-loop feedforward and closed-loop feedbackward controls, are integrated with control devices and thrust vectoring propulsion systems. The combined controller with control devices provide the control and manuvering of the vehicle crusing at ultra-high speed. With recent advances in smart materials, control laws, and intelligent controllers, such control devices are very realistic and achievable.

PHASE I: Conduct feasibility study of techniques to control the high-speed supercavitating bodies. Design control devices and intelligent controller to control and maneuver the vehicle.

PHASE II: Develop and test control devices and associated control algorithms for high-speed supercavitating bodies. Experiments and testing will be conducted in the laboratory or in-water to demonstrate the validity of control concepts.

PHASE III: Extend the Phase II effort to incorporate control devices and control methodology for high-speed supercavitating torpedoes, projectiles and fast ships. Collaborate with Navy Labs and industry to develop controllers and control devices for supercavitating torpedoes and fast ships.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The supercavitation concept can be applied to fast ships and high-speed surface crafts. Controlled gaseous injection near the wetted surface of ships could lead to reduction in drag, and hence faster speed and/or reduce fuel consumption.

REFERENCES:
1. Ashley, Steven, “Warp Drive Underwater,” Scientific American, May 2001.
2. Graham-Rowe, Duncan, “Faster Than a Speeding Bullet,” New Scientist, July 2000.

KEYWORDS: Adaptive Control; Supercavitation; Two-Phase Flows; Smart Materials & Structures; Undersea Weapons; Fast Ship

N04-137 TITLE: Probabilistic Error Estimation In Model-Based Predictions

TECHNOLOGY AREAS: Ground/Sea Vehicles

ACQUISITION PROGRAM: DD(X)

OBJECTIVE: To quantify the confidence in the predictions from model-based simulations used to evaluate the effects of dynamic loads on ship structures.

DESCRIPTION: The Navy relies on model-based simulations to design and predict the performance of advanced systems. These models and simulations involve multiple, interdependent variables. A method to quantify the error(s) associated with the interaction of multiple, interdependent variables is needed to ensure the quality and confidence in the simulations' predictions. While significant work has already been invested in quantifying those errors that stem from numerical approximations such as mesh resolution and integration algorithms, the errors associated with limitations on experimental evidence have not been addressed. Quantifying these errors is important for deciding on the design of experiments in a manner that is consistent with the predictions from model-based simulations. Estimates of these errors are also expected to play an important role in managing the transition from full-scale tests to increased reliance on modeling and analysis. Recent developments in probabilistic modeling, specifically in the area of stochastic finite elements and uncertainty quantification, provide a path for developing rational estimates for the above errors based on a probabilistic framework.

Development should focus on commercially available codes for the analysis and simulation of extreme loading and high rate events, which involve fluid and structure interaction.

PHASE I: Address available technologies for quantifying the confidence in model-based predictions. Develop pathways for integrating them with commonly used simulation software. Demonstrate the benefits and technical implementation approach.

PHASE II: Develop software that implements error estimation technology and interfaces to commonly used analysis packages.

PHASE III: Refine the implementation and identify guidelines for using the developed software in monitoring the planning and execution of large-scale tests of engineered systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: In addition to Navy ships and submersible applications, the proposed software will have relevance across a very wide spectrum of applications. These include any application that relies on modeling for decision-making, as well as applications that could benefit from modeling if confidence in the associated predictions were better quantified. Commercialization is envisioned in the aerospace, automotive, oil and gas, and manufacturing industries.

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3. Ghanem, R., "Stochastic finite elements for heterogeneous media with multiple random non-gaussian properties" ASCE Journal of Engineering Mechanics, Vol. 125, No. 1, pp. 26-40, 1999.
4. Liu, W.K., Besterfield, G. and Belytschko, T., "Transient probabilistic systems", Computer Methods in Applied Mechanics and Engineering", Vol. 67, pp. 27-54, 1988.
5. Millwater, H., Palmer and Fink, P., "NESSUS/EXPERT - An expert system for probabilistic structural analysis methods", 29th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Williamsburg, Virginia, April, 18-20, 1988.

6. Oberkampf, W., et al., "AIAA Guide for the Verification and Validation of Computational Fluid Dynamics Simulations" AIAA Journal (G-077-1998), 1998.

KEYWORDS: Probabilistic nonlinear finite elements, Model-based prediction, design experiment, computational mechanics, error estimation, confidence, large-scale tests, certification.

N04-138 TITLE: Real-time Data Fusion and Visualization Interface for Environmental Research Data.

TECHNOLOGY AREAS: Battlespace

ACQUISITION PROGRAM: PEO (IWS)

OBJECTIVE: Develop an interactive, user-configurable command and control system that records, monitors, fuses, and displays real-time data from multiple airborne payloads, and disseminates graphs and tabular data to remote users via SATCOM and the Internet.

DESCRIPTION: Atmospheric measurements carried out by use of small research aircraft will be greatly enhanced by a data system capable of not only acquisition of data, but also of on-the-fly data reduction, fusion of data sets, graphic representation of the data, and dissemination of the data to users on the ground. Mission controllers, mission scientists and sensor engineers thus will have real-time access to the data and data products, and can from their offices provide support via a bi-directional communications link to the flight director aboard the aircraft. Such a data and communications system enables an entire science or engineering team to remotely participate in the execution of mission plans and in ascertaining instrument performance, instead of leaving these functions to a flight crew and often a single flight director (albeit a scientist or an engineer). The instruments providing the data to the system range from simple analog signal generating transducers to sophisticated systems providing digitized streams of data using serial or ethernet protocols. Thorough time synchronization of data from various such instruments is required, as well as flexibility in adapting fast and easily to changes in payload configuration. The graphical interfaces of the system must allow user-configurable displays. They must be able to fuse the aircraft data with real time, sequential graphics from metrological satellites, radars, and meteorological models, and must allow the data to be simultaneously merged in such fusion with data obtained by use of similar systems aboard other aircraft or ships. The communication component should be able to use utilize Radio and SATCOM data links and as well as the Internet for dissemination and transmission of a broad range and form of data and data products. The system should allow for direct communication with individual instruments from the ground during flight, to permit remote configuration changes on-the-fly by instrument mentors. The system should be easily adaptable to changes in available communication bandwidth, and should maximize bandwidth utility by means of modern data compression techniques.

PHASE I: Design and develop a prototype system's architecture that performs the basic remote operation, the real-time mission data management, the data dissemination, the data fusion and the data display.

PHASE II: Develop and demonstrate a fully operational remote site data management system from a research aircraft for use with multi-sensor and multi-user, and multi-platform field experiments. The system should support multiple payloads and customizable instrument displays. Develop a commercialization (Phase III) plan, including descriptions of potential customers, missions, demonstrations and transition efforts to be performed.

PHASE III: Transition the data system into a commercial data and display system, which could be utilized by various research facilities on a variety of platforms, including aircraft, ships or ground based operations. Support data system integration for customer-specified research platforms. Commercial data system should include documentation and spare parts.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Private sector applications and benefits are inherent in the objective of the proposed effort. Existing data management systems used by government or private research organizations should benefit from the added interactive data dissemination and display features of this system.

REFERENCES:

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KEYWORDS: Real-time Data Collection; Visualization; SATCOM; Internet; Data Management; Data Fusion, and Instrument Control.

N04-139 TITLE: An aircraft instrument for measurement of absorption at multiple wavelengths in the atmosphere.

TECHNOLOGY AREAS: Battlespace

ACQUISITION PROGRAM: PEO (IWS)

OBJECTIVE: Develop an instrument that accurately measures the absorption coefficient of aerosol samples at several wavelengths from an aircraft

DESCRIPTION: Among the greatest uncertainties in determination of attenuation of electromagnetic waves in the atmosphere is the fractional loss due to absorption by aerosols. Measurement of the absorption coefficient of aerosols may be done in controlled environments by use of filter techniques, or large-path extinction measurements, but adapting these techniques to use on ships or aircraft has proven difficult. New approaches, such as photo-acoustic techniques, or ring-down cavity measurements may now hold promises for solutions to this problem. Answers to fundamental questions about processes involving visibility, target imaging, signal and communication transmissions, which are important to the Navy, or to radiative heat transfer in the atmosphere, and interpretation of data acquired by means of lidars, radiometers, and other laser scatter or extinction probes, which are important to the scientific community at large, will be forthcoming if accurate, multi-wavelength measurements of the absorption coefficient from mobile platforms become possible. In accordance with good aviation practice power need for the instrument and its size and weight should be minimized. Data should be transmitted in digital form from the instrument and be legible to simple, common data systems (Eathernet, USB, Serial).

PHASE I: Design a prototype system that measures multi-wavelength absorption at a rate of approximately 1 Hz on a noisy, vibrating, aircraft.

PHASE II: Develop and demonstrate a fully capable multi-wavelength absorption instrument for use with a research aircraft. Develop a commercialization (Phase III) plan, including descriptions of potential customers, missions, demonstrations and transition efforts to be performed.

PHASE III: Transition the system into an operation adsorption instrument to include documentation, calibration and other tools and spare parts. Support adsorption instrument integration for government customer-specified platforms. Finalize requirements for an adsorption instrument that would allow its utilization by various research facilities on a variety of platforms, including aircraft, ships or ground based operations.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The possibility of commercialization is tied to the lack accurate, fast multi-wavelength absorption photometers. The demand for such devices, however, may be expected to be fairly large due to the variety of interests in accurate absorption measurements. For example people interested in visibility need absorption measurements. So do people working on interpretation of radiometer data obtained from satellites. The latter, in particular, and multitude of others are interested in being able to do this from an aircraft.

REFERENCES:

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2. Schmid, B., J. M Livingston, P. B. Russell, P. A. Durkee, H. H. Jonsson, D. R. Collins, R. C. Flagan, J. H. Seinfeld, S. Gasso, D. A. Hegg, E. Ostrom, K. J. Noone, E. J. Welton, K. J. Voss, H. R. Gordon, P. Formenti, and M. O. Andreae, 2000: Clear-sky closure studies of lower tropospheric aerosol and water vapor during ACE-2 using airborne sunphotometer, airborne in-sity, space-borne, and ground-based measurements, Tellus (ACE-2 Special Issue), 52B, 568-593

KEYWORDS: Real-time Data Collection; Radiation; SATCOM; Internet; Data Management; and Instrument Control.

N04-140 TITLE: Advanced Oil Viscosity Measurement Technique

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: PMS 500

OBJECTIVE: To develop a method of determining fluid viscosity through infrared spectroscopy or other optical techniques.

DESCRIPTION: Accurate oil viscosity measurement is very important in diesel engine lubricant analysis as an indicator of fuel dilution of the oil. Presently, the only method of determining oil viscosity is through stand-alone viscosity measurement instrumentation that is expensive while adding weight to portable fluid analysis systems. What is required is a method of "backing out" or inferring fluid viscosity from existing infrared and/or optical measurements.
The Navy is now developing and testing two integrated fluid monitoring systems.

The first is the Total Oil Monitoring System being tested both aboard ship and at NAVSSES Philadelphia. TOMS integrates a commercially available particle debris monitor with a portable FTIR device for online oil analysis applications. For diesel engine monitoring, viscosity is determined using a commercial viscometer ($10K each).

The second integrated system under both test and development is the Portable Fluid Analyzer (PFA). PFA integrates the LaserNet fluid debris monitor with the portable FTIR device used in TOMS (above). PFA is being designed specifically as a man-portable unit capable of on the spot analysis of oil, hydraulic fluids and fuel. Like TOMS, PFA diesel oil analysis requires a viscosity measurement that can only be done by a COTS viscometer. PFA will be tested by the Fleet Technical Support Centers Atlantic and Pacific, PEO Carriers for Aircraft Carrier Emergency Diesel Generators and the Advanced Amphibious Assault Vehicle main propulsion diesel engine.

PHASE I: Using method(s) proposed, conduct preliminary experiments to prove the validity of the viscosity measurement technique(s) and demonstrate the accuracy of the measurements in a blind test against state of the art, commercially available viscosity measurement instrumentation.

PHASE II: Integrate the measurement technique into existing infrared and/or optical measurement instrumentation for full-scale field demonstration and validation by the Joint Oil Analysis Program and/or other fluid test and measurement standards bodies. Performer should be prepared to demonstrate the capability in (at least) two separate demonstration (host) platforms provided by the government.

PHASE III: This viscosity measurement technology would transition into the commercial sector for integration into current and future fluid analysis systems used within DoD. Platform transition targets are DDX, AAAV, LAV and CVN(X).

PRIVATE SECTOR COMMERCIAL POTENTIAL: This technology has a huge worldwide market for those industries that rely on diesel power. Already, Caterpillar (the world's largest diesel engine manufacturer) has expressed interest in this capability. To date, the cost and weight associated with individual viscosity instrumentation is holding back worldwide demand for portable fluid analysis instrumentation.

KEYWORDS: viscosity; fuel dilution; Fourier Transform Infrared Spectroscopy (FTIR); oil analysis; oil chemistry; laser

N04-141 TITLE: Sensors and Techniques for Networked Autonomous Oceanographic Systems

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO (IWS)

OBJECTIVE: Develop low-weight, low-power and low-volume instruments/sensors/techniques to autonomously measure oceanographic parameters, especially as a part of a networked system of mobile and stationary systems.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain oceanographic variables (e.g., physical, chemical, optical) in 3-D space and time. In addition, future platforms are envisioned to include networks of platforms (both fixed and mobile) operating autonomously and in concert with each other. Emphasis of proposals should be placed on (1) novel approaches and concepts for measuring particular parameters in 4-D from remotely piloted aircraft (RPAs), autonomous underwater vehicles (AUVs), ships, buoys, or expendables; (2) developing the next generation of low-cost, potentially expendable instrumentation usable in both navy operational scenarios as well as in science and technology environmental data collection; (3) developing enabling technologies for long-duration (weeks to months) autonomous operations; and (4) developing technologies for real-time wireless networks of sensors, especially for the littoral battlespace environment (out to roughly 400 km from shore). The coastal zone is an extremely difficult environment to work in, due to relatively short spatial coherence scales and the short time scales of environmental variability. This solicitation would include, therefore, not just new sensors for deployment on an AUV, for example, but would also encompass novel instrumentation or techniques for connecting what may be a dense system of AUVs and other sensors with the Internet. The term "expendable instruments" includes both one-time usage as well as long-term in situ usage and the sensors should be affordable if expendability is required but reusable if not.

PHASE I: Provide both an exact description of the capability (measurement or technique) to be demonstrated including accuracy and sensitivity along with the instrument design concept for achieving the capability.

PHASE II: Produce a viable prototype system and demonstrate its ability to support field capability from an appropriate platform.

PHASE III: Transition the technology to scientific use in the atmospheric, oceanographic or environmental monitoring research communities, or to operational DoD systems.

PRIVATE SECTOR COMMERCIAL POTENTIAL: New instruments can be used in a wide variety of commercial environmental monitoring systems, and in government-sponsored long-term ocean monitoring efforts such as those supported by NOAA and the National Ocean Partnerships Program (NOPP). Advances in wireless networking have a strong likelihood of becoming commercially valuable (ref. 5).

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3. http://gcn.com/22_8/tech-report/21747-1.html
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KEYWORDS: Oceanography sensors; autonomous systems; coastal observations; wireless network; telemetry

N04-142 TITLE: Technology for Shipbuilding Affordability

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: National Shipbuilding Research Program (NSRP) Advanced Shipbuilding

OBJECTIVE: The objective of the project is to develop and implement innovative technologies that will reduce the cost to construct ships and thereby improve the competitiveness of the domestic shipbuilding industrial base and reduce the cost of military ships.

DESCRIPTION: US shipyards along with suppliers, owners, operators, and government personnel have developed the NSRP Advanced Shipbuilding Enterprise (ASE) Strategic Investment Plan (SIP). This plan contains an industry led strategy to promote commercial competitiveness and reduce the cost of military ships. It identifies Major Initiatives and Sub-Initiatives that are the R&D requirements for this industry. This entire plan is available for review on the World Wide Web at http://www.nsrp.org/. Coordinating with U.S. shipbuilders to adapt and implement "World Class" commercial best practices is encouraged. Of particular interest are initiatives directed toward implementing lean enterprise concepts. Proposals should indicate which areas are being addressed. Awards are planned to made to the highest rated proposals overall and not set aside within each research area.

Proposals should specifically describe the technology that will be applied to solve the problem, how it will be developed, what the estimated benefits will be and how it will be transitioned into the shipbuilding industry.

Teaming with the shipbuilding industry to form integrated project execution and implementation team will improve transition potential and is strongly encouraged. Shipbuilding industry contacts are available at http://www.usashipbuilding.com under The Panels button.

Proposals under this topic must address at least one of the following research areas related to the SIP:
1. Process Control
Develop, pilot, and provide to industry process control programs that address and/or employ standardized production processes, accuracy control techniques, and improved cost/schedule/quality management methodologies, based on a risk impact assessment. These efforts should focus on:
Automated creation of CAD models from point cloud data
Distortion control technology
Statistical process control expansion

2. Manufacturing Technologies
Develop, pilot, and provide to the industry, manufacturing technologies (e.g., surface preparation and coatings, welding and joining, forming, etc.) process and/or material improvements that would result in measurable labor, cycle time and/or material savings. Focus areas to be considered include:
Technologies that support facility modernization (e.g., outfitting, platens, dock elevators, launch and transfer systems) for greater worker productivity
Coating automation
Joining technology
Material cutting, forming, and processing
Cost-effective safety, health, and environmental improvements to these processes

3. Advanced Product Designs and Materials
The Advanced Product Designs and Materials sub-initiative includes the identification and development of new and "breakthrough" product designs and advanced materials required to ensure U.S. shipyards market differentiation in the ships of the future. Focus areas to consider may include:
Advanced design, simulation, analysis, estimating -- develop software programs that can calculate the square footage surface area for each part that is designed and that requires painting, and then be able to link that information to paint shop bidding, estimating and inventory control computer systems
Automated cargo handling capability
Protective coating

Advanced composite structures
Regulatory implementations associated with promising advanced product designs and materials

PHASE I: Prove feasibility for improvements being developed and detail where and why they will impact shipbuilding affordability. Include a Return-On-Investment (ROI) analysis for industry implementation and close collaboration with a shipyard customer to validate feasibility and marketability.

PHASE II: Develop a working prototype production system or prototype product to demonstrate its performance characteristics. Present the technology being developed to the NSRP ASE Major Initiative and technology panels, develop a commercialization (Phase III) plan, in coordination with NSRP ASE members, including descriptions of specific tests, evaluations and implementations (including sites and points of contact) to be performed.

PHASE III: Implement the Phase III plan developed in Phase II in coordination with the NSRP ASE Program.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology developed under this topic shall be applicable to both military and commercial shipbuilding practices and marketable to the shipbuilding industry.

REFERENCES:
1. NSRP ASE Strategic Investment Plan, available on line at http://www.nsrp.org/
KEYWORDS: shipbuilding; affordability; production; manufacturing; processes; maintainability

N04-143 TITLE: Close Range Imaging Sensor for UCAV

TECHNOLOGY AREAS: Air Platform, Sensors

ACQUISITION PROGRAM: UCAV

OBJECTIVE: Develop a very small infrared sensor with pan/tilt/zoom capability that could be used for close range machine vision applications, such as UCAV carrier flight deck handling or autonomous air-to-air refueling.

DESCRIPTION: In order to effectively handle taxiing UCAVs on the carrier flight deck with minimal impact to current operations, the Navy is experimenting with concepts that automatically recognize the flight deck directors' gestures. A sensor would be mounted on the aircraft that could acquire the director image and on board algorithms would conduct classify the images. Such a concept could avoid increased flight deck manning and associated costs. Additionally, this sensor could be used for autonomous air-to-air refueling, if this becomes a requirement.

The sensor is an important component to this concept, and requirements are demanding. The sensor must be very small and lightweight; approx 8 cu. in. and 5 lbs max. The sensor could be mounted on the retractable refueling probe. It must operate in all-weather and employ cooperative targeting, therefore infrared is highly desired. It must acquire images at a range of 10 to 250 feet with a field of view of +/- 100 deg. Spatial resolution should be such that the arms/hands of an average person can be clearly discerned at 250 feet. Pan/tilt/zoom concepts are acceptable, provided it can fit in the small package (see above). Requirements for air-to-air refueling are less stringent: Max range is 40 feet, target size (refueling drogue) is 27 inches in diameter, field of view is less than +/- 100 deg.

A close-range, large field-of-view, IR sensor would have a broad application in both military and non-military. This sensor would provide an unmanned ground vehicle with superior imaging for obstacle avoidance, situational awareness, and object recognition functions. It would also be useful for surveillance and force protection applications.

PHASE I: Conduct an analysis to confirm the performance requirements. Assess the feasibility of developing the sensor that meets the requirements. Work with the UCAV-N prime contractor to confirm the size/weight requirements and the impact to the airframe. Provide a per unit cost estimate and a mean-time-to-repair/mean-time-between-failure estimate.

PHASE II: Produce a prototype sensor for testing. Verify performance requirements through lab/shorebased demonstration.

PHASE III: Transition to the Joint-Unmanned Combat Air System (J-UCAS) program through production agreement with the J-UCAS prime contractor. Demonstrate form-fit-function with J-UCAS aircraft.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The potential market for a very small, lightweight infrared sensor is broad. Commercial applications include consumer electronics, surveillance, warehouse inventory, and traffic monitoring.

REFERENCES:

1. "Gesture Recognition for UCAV Flight Deck Operations," NAVAIR report dated 23 Jan 03
2. F/A-18 Nose Landing Gear dimensions can be found in NAVAIR Manuals A1-423AC-130-010, -020, -030. These manuals are available via Naval Air Technical Data and Engineering Services Command (NATEC) website: http://www.natec.navy.mil. (Because the J-UCAS is in a competitive phase, design information is not available. F/A-18 aircraft can be used as a surrogate.)

KEYWORDS: Imaging Sensors, Machine Vision

N04-144 TITLE: <u>Thermal Imaging of the Head for the Sensing and Identification of Concealed Intent</u>

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace, Human Systems

ACQUISITION PROGRAM: BUMED, N091

OBJECTIVE: Develop imaging devices capable of measuring thermal activity in the head for the purpose of detecting and identifying concealed intent. Of particular interest is imaging of thermal brain activity emanating from the skull over particular cortical regions.

DESCRIPTION: For decades investigators have relied on polygraph testing to yield answers as to whether or not suspects are concealing the truth. Polygraph testing is a peripheral nervous system response involving cardiovascular activity, galvanic skin response and changes in respiration. These types of measurements can be extremely variable from person to person, and require highly trained and skilled individuals to evaluate the data which cannot be done in real time. Recent research has focused on two types of infrared imaging for the real time detection of deception. Research using a wearable near infrared light sensor has detected changes in the frontal lobe of the brain, changes based on the oxygenation and deoxygenation of blood, associated with lying or intended deceit. Other research using infrared cameras to detect thermal changes in the face, indicates that there are thermal signatures on the human face that may be reliably correlated with deceit. Data from functional magnetic resonance imaging studies (fMRI) has noted that activity in a particular region of the frontal cortex, the anterior cingulate, may be significantly correlated with lying or concealment of truth. The advantage of the central nervous system signals is they are not as variable and volatile as the peripheral nervous system activity typically recorded with polygraphs. If this brain signal could be reliably identified, it could greatly facilitate the rapid and non disruptive identification of deceptive answers to questions at U.S. borders, military checkpoints, civilian airports, customs and entries to critical facilities. The purpose of this topic is to determine if there is sufficient thermal signal coming from the cortical regions associated with deception, and then develop imagers that can be used to detect this activity at a distance. Modern IR technology is robust and rugged enough to be used in operational or civilian environments. Thus the critical factors for this topic will be detecting the regions of interest, and then developing imaging systems that have the thermosensitivity needed to resolve this brain signal. This detection should be able to be conducted at a room sized distance, approximately 5m, and the systems must have sufficient signal processing to measure the desired signal through the average head of hair and various skin colors. Additional attention should be focused on the operational method of employment, including the need for better signal processing software, and a clear articulation how to overcome the localization challenges at a distance.

PHASE I: Conduct a feasibility study to identify thermal signals resulting from the brain activity correlated with deceit. Conduct a study to characterize typical thermal fluctuations on the human head under a variety of conditions, including the temporal window for responses. This effort may be combined with thermal imaging of the face for a comprehensive comparison of the approaches. A solid analysis that builds on the body of literature and related areas should provide the foundation for this study.

PHASE II: Develop a prototype thermal imager that will be used to visualize the identified signals from the face and brain. Imager must function in a room sized distance, with standard room background temperatures. Imagers can have standard pixel size 60-100 microns, but must have enough resolution to define the area of interest from surrounding tissue.

PHASE III: Develop thermal imaging systems for dual use in civilian and military settings for the "at a distance" analysis of deception in suspects.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There is a considerable commercial base for IR imaging systems, and IR imagers are used in a wide variety of government and commercial applications. Advances in thermal imaging will benefit the commercial community, including industrial manufacturing and biomedical applications.

REFERENCES:
1. Langleben, D.D., Schroeder, L, Maldjian, J.A., Gur, R.C., McDonald, S., Ragland, J.D., O'Brien, C.P. and Childress, A.R., 2001. RAPID COMMUNICATION, Brain Activity during Simulated Deception: An Event-Related Functional Magnetic Resonance Study, NeuroImage, May 2001.
http://www.sas.upenn.edu/jerrylee/1003a.pdf
2. Ioannis Pavlidis, Norman L. Eberhardt, James A. Levine: Human behaviour: Seeing through the face of deception, Nature 415, 35 (2002);
http://www.nature.com/cgi-taf/DynaPage.taf?file=/nature/journal/v415/n6867/full/415035a_fs.html&content_filetype=pdf

KEYWORDS: thermal imaging, concealed intent, non invasive functional imaging, thermal brain imaging

N04-145 TITLE: Deployable Micro Weather Sensor

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: PEO C4I & Space/PMW 155

OBJECTIVE: Develop a small, lightweight weather sensor that can be easily deployed from manned and unmanned platforms and by warfighters on the ground.

DESCRIPTION: 21st Century war planners are placing an ever-increasing emphasis on technologies that have stealth and speed characteristics -- that is, those technologies that can be deployed and operated covertly and quickly tend to be highly favored for use. Dynamic weather conditions in the target area is a critical factor in selecting the correct mix of ISR sensors and munitions for locating and destroying enemy capabilities. Weather sensors permanently installed on satellites and on manned and unmanned air platforms can provide top-down views of weather conditions, but they are not capable of measuring specific ground-level conditions in the target area.

The goal of this project is to design, develop and prototype miniaturized sensor technologies that, when combined, have the following core characteristics:

1. Ability to be deployed from air platforms -- manned and unmanned -- and by ground forces
2. Low-cost, small, disposable and compatible with packaging in legacy munitions containers/dispensers
3. Integrated Global Positioning System (GPS) and low probability-of-intercept (LPI) communications capabilities
4. Capability to measure pressure, temperature, dew point, wind direction and speed at, or near, ground level.

PHASE I: Research state-of-the-art sensor, GPS, LPI and packaging technologies. Design a prototype weather sensor capability that provides the core characteristics listed above.

PHASE II: Iteratively develop, test and document a prototype capability based on the initial design from Phase I and that can be deployed from an altitude of at least 10,000 feet.

PHASE III: Develop, test and install on a suitable platform the sensor package capability resulting from the Phase II effort. Support an operational demonstration of the sensor package. Report the demonstration results. Transition the sensor capability to the appropriate Service acquisition agent for commercialization.

COMMERCIAL POTENTIAL: The military and intelligence agencies of our closest allies could benefit from this sensor technology. There is no other likely private sector market.

REFERENCES:

1. DoN "Naval Transformation Roadmap," July 2002 (e.g., page 26)

KEYWORDS: weather; target area; miniaturization; sensors; deployable; covert

N04-146 TITLE: Dynamically Configurable Antenna

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Ship Signal Exploitation Program, ACAT III

OBJECTIVE: Develop a single antenna or group of antennas that will operate in the 200 KHz to 3 GHz frequency range and that can be dynamically switched between omni-directional and directional operation.

DESCRIPTION: Current systems operate in an omni-directional mode. This mode of operation must be maintained for its advantages, but the increased directionality of the antenna in directional mode and the resultant increased gain will support:

(a) Communications: Increased data rate, reduced EMI, improved weather and jamming link margins, and less probability of detection by enemy forces.
(b) Direction Finding: Detect lower power Signals Of Interest (SOI), detect SOI at greater distances, and provide a smaller location error ellipse.
(c) Jamming: Enable shipboard jamming (currently not done due to EMI) and provide more energy on target when jamming.
(d) Develop smaller, lower profile antenna design for use on new ship classes.

The effort is to investigate the feasibility of technology that gives the Navy the ability to tailor its antennas for the mission and the phase of the mission. Example: Detect a SOI in omni-directional mode and then switch to directional mode for direction finding.

PHASE I: Determine the feasibility of developing a low cost antenna(s) for shipboard use that will operate in the 200 KHz to 3 GHz frequency range. A single antenna is preferred. The antenna must support simultaneous transmit & receive in the 30 MHz to 3 GHz frequency range (full duplex). In the 200 KHz to 30 MHz frequency range the antenna must support both transmit and receive, but is not required to support both simultaneously (half duplex). The antenna must interface with existing shipboard radios and associated systems. Minimal physical size and weight (minimal "footprint") is preferred. Antennas requiring manual reconfiguration to support operation will not be considered. A beamwidth of 1 to 3 degrees is desired when operating in directional mode. A gain of zero dB or better (positive gain) is required and a gain of 10 dB is desired.

PHASE II: Develop, test, and deliver a ship qualified prototype dynamically configurable antenna that meets the criteria of Phase I. Provide it's supporting design, test (performance, environmental, etc.), installation and maintenance documentation.

PHASE III: The product will transition to existing Navy PEO C4I & Space PMW189 and NIWA PMW188 programs of record. Other potential government customers would be US Coast Guard, State Department, Homeland Security Department, etc.

PRIVATE SECTOR COMMERCIAL POTENTIAL: There are two potential customers for the DCA. The first is any commercial or government entity that requires high data rate communications between mobile users. Commercial shipping is one example of potential commercial customers. United States Government customers would be all Department of Defense (DoD) components (Navy, Marine Corp., Army, Air Force, NSA, etc.) and the Department of Homeland Security (US Coast Guard) at a minimum. The second customer for the DCA would be any (probably government) organization that needed to locate the position of a transmitter for public safety, law enforcement, Homeland Security/Defense, or Military needs. For example the US Coast Guard could use the antenna to help locate small craft in distress whose operators weren't sure of their position. Another example would be for the Drug Enforcement Agency to use the system to locate drug traffickers. A further example would be DoD using the system to locate terrorists in support of Homeland Security/Homeland Defense. Thus there would be high potential for government sales. The DCA will have a strong potential for dual use and commercialization.

REFERENCES:

1. Naval Information Operations Capstone Requirements Document, by FIWC, Draft 15APR99

2. Unified Cryptologic Architecture, Systems Architecture

KEYWORDS: Antenna; Ultra High Frequency (UHF), Very High Frequency (VHF); High Frequency (HF); L-Band; Ship

N04-147 TITLE: Tactical Secure Voice/Data Encryption Device

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Secure Voice Program, SPAWAR PMW-161

OBJECTIVE: Develop an open architecture and encryption technology for Fleet narrowband secure voice for improved voice quality, interoperability, reconfigurability, and upgrade ability.

DESCRIPTION: Operation Iraqi Freedom evidence a huge surge in the use of secure voice. A large part of this surge of employment of secure voice involved tactical radio links and mobile users, where the voice quality was inadequate. The Advanced Narrowband Digital Voice Terminal (ANDVT) voice quality over tactical radio must be improved. In addition, the voice quality is inadequate at extremely low data rates required for naval covert and underwater communications. The system is too slow and is not sufficiently anti-jam. This effort will concentrate on dsigning an open architecture and identifying technical solutions for the development of a new COMSEC device to replace all legacy devices. This Secure Voice Data Terminal (SVDT) should incorporate the Future Narrowband Digital Terminal-210/230 (FNBDT-210/230) signaling plan and be able to support low bandwidth secure voice and data applications over High Frequency (HF), Ultra High Frequency (UHF) Line of Sight (LOS), Extreme High Frequency (EHF), Low Data Rate/Medium Data Rate (MDR), and Super High Frequency (SHF) designated Radio Frequency (RF) mediums. This pertains to both netted and point-to-point operations. This effort will provide a Joint Interoperable narrowband secure crypto capability for the DoN with enhanced capabilities such as rapid reconfigurability, improved security and improved voice quality.

PHASE I: Design an open system architecture for Tactical Secure Voice/Data Encryption Device that will support insertion of new technologies and algorithms for near and mid term requirements, including technologies investigated in Phase II and Phase III.

PHASE II: Develop a solution for narrowband tactical vocoder rapid synchronization for data encryption over combat radios.

PHASE III: Develop and improve a low-data-rate voice algorithm with the special emphasis on low power consumption for mobile applications (i.e., the voice processing algorithm must reduce computations and data storage). Investigate a voice processing algorithm operating at the extremely-low-data-rate of 20 bps or less for special Naval applications (i.e., anti-jam, covert or underwater voice communications).

PRIVATE SECTOR COMMERCIAL POTENTIAL: This open architecture design will support the various requirements and technologies, while also provide interoperability among DoD, coalition, FEMA, homeland security, and first responders. Health care, banking and security organizations can both use and contribute to this architecture and technologies designed to work within the architecture.

REFERENCES:
1. FNBDT-210 FNBDT Signaling Plan 1999 (Enhanced firefly messaging)
2. FNBDT-230 FNBDT Cryptology Plan 1999
3. SIP IP Call signaling and control
4. Selsius Skinny Station Protocol
5. H.323 Call signaling and control
6. MIL-C-28883 Military Specification for the Advanced Narrowband Digital Voice Terminal (ANDVT) Tactical Terminal (TACTERM) CV-3591.

KEYWORDS: Crypto; Secure; Mobile; Encryption; Data; Tactical

N04-148 TITLE: RF Solution to Narrow In-Band Interference in UHF SATCOM Channels

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: P31 to Mini-Dama (ACAT III)

OBJECTIVE: Demonstrate tunable filter hardware to manage or remove multiple very narrow (3kHz, ~ .001% bandwidth) interference within the signal structure of UHF channels without increasing the noise figure of the system or impacting proper demodulation of the transmitted waveform.

DESCRIPTION: Multiple narrowband interferers significantly impact users of UHF SATCOM channels by reducing available data rates and preventing the availability of some channels entirely. Since most channels are shared, the interference impacts many users simultaneously. A method is needed to remove the interference from the band for the purpose of increasing the utility of the channel. Surveillance activities also require the ability to reduce interference in order to capture desired signals. Intentional jamming or the presence of a local interferer are also potential threats for both communications and surveillance activities, since the strong signal can overload the receiver or render its dynamic range inadequate to capture the desired signal. Since multiple interferers are typically present, many need to be removed simultaneously. Conventional RF notch filters do not carve out a sufficiently narrow notch and they impact the overall noise figure excessively -- especially when many of them are used together. An analog or digital solution may be possible, but either approach needs to address multiple interferers simultaneously and track them as they appear and disappear, with minimal input by the user. In order to be fieldable by both the communications and surveillance communities, the implementation must be capable of retrofit into existing systems as well as capable of integration into future systems.

PHASE I: A study and design of an RF front end system to remove multiple narrowband interferers and significantly improve receiver performance.

PHASE II: Build and test in the lab the subsystem designed in Phase I.

PHASE III: Build prototype suitable for at-sea deployment. (This may be the militarization of the prototype developed for Phase II.) Perform at-sea demonstration of prototype for both communications and surveillance applications.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The technology used for this project is anticipated to be scalable to commercial spectrum use. The primary commercial potential would be in the mobile communications industry to increase the range of base stations. It could also be used in any high-bandwidth commercial application in which interference from other users was a problem. In particular, this technology may be an enabler to increase the value of commercial spectrum, which cannot currently be fully utilized due to the impact of an interferer.

REFERENCES:

1. "Superconducting Notch Filter for 171 MHz," http://www.grc.nasa.gov/WWW/TU/electron.htm, NASA Glenn Research Center Electronic Components and Circuits Tech Briefs, Dec 1996, 56, LEW-15875
2. J. Terrell, "High Temperature Superconducting Filters for Military Applications," GOMAC, March 1999
3. Soares et al, IEEE-MTT 48(7) July 2000

KEYWORDS: tunable; notch; filters; UHF; EW; superconductivity

N04-149 TITLE: <u>Command and Control Communications System Denial</u>

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: Signal Exploitation Equipment (SSEE); ACAT III

OBJECTIVE: Disrupting enemy command and control communications networks are an important capability for protecting operating forces or engaging hostile threats. There are times denying or deceiving hostile communications is needed to force behavior modification of hostile entities. The purpose of this SBIR is to research, design, and develop technology to enable tactical denial of access to communications services or to force modification of communication services used by opposing forces.

DESCRIPTION: In many situations, deployed forces encounter hostile forces that typically coordinate tactical force disposition and military maneuvers using command and control communications. Even if no specific target is identified, the capability to deny the adversary access to their command and control system in real-time using varying degrees of selective countermeasures is needed. The system must be sufficiently flexible to allow application against a regional network, a local sectorized portion of the network, or against specifically identified entities using the network. Both service denial and service modification functionality are desired.

PHASE I: This phase consists of examining present typical shipboard RF configurations for transmitting and receiving information through existing RF Distribution Systems for communications and IW (signal exploitation and counter-communications) in the HF through UHF frequency range. Based on current and advanced RF technology, conduct technological tradeoffs to determine the range of performance achievable, the degree common functions can be combined and possible basic RF design schemes. The tradeoffs must address technical risk.

PHASE II: Based on the selected basic design, complete a detailed design. Prototype and prove out key elements of the design where significant performance risk is known to exist. After identifying the technical risk associated with the design and critical RF component selection, conduct a critical design review (CDR). Following the successful CDR, build, test, and demonstrate a prototype system.

PHASE III: The design achieved in Phase II has numerous commercial applications where Joint Forces, Immigration and Naturalization Service, Drug Enforcement Agency and extensive foreign sales opportunities. For the Navy the System will be developed for compatibility with the Ships Signal Exploitation Equipment (SSEE) and in this phase will consist of manufacturing sufficient numbers of production versions of the System in order to demonstrate the operational viability and effectiveness of the unit. Upon satisfactory completion of shipboard installation and integrated product demonstration, the System project will transition to the standardized process of Fleet introduction and general incorporation into both new construction and back-fit modernization programs.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Primary customers will be joint and coalition militaries.

REFERENCES:
1. Joint Publication 3-13, Joint Doctrine for Information Operations, 9 Oct 98.
2. Joint Publication 3-58, Joint Doctrine for Military Deception, 31 May 96.

KEYWORDS: Information Operations; Command and Control Networks; Cryptology; Denial; Deception; Information Warfare

N04-150 TITLE: Radio Room RF Integrated Switching Matrix

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

ACQUISITION PROGRAM: P3I for ACAT III Program (OE-538 submarine antenna)

OBJECTIVE: Replace a conventional electro-mechanical RF/microwave switching matrix with a highly reliable, scalable, flexible, broadband, low-loss, medium power, shock resistant, and humidity-resistant integrated switch matrix system with a “failsafe” mode, suitable for military communications capabilities, and harsh environmental conditions.

DESCRIPTION: The automation of shipboard radio rooms, which is needed to support increasingly complex radio frequency (RF) and microwave communications system requirements in conjunction with fleet personnel reduction, requires the replacement of legacy manual or semi-automatic switching with automatic switching systems – without impact to performance or reliability. Automatic switching systems that are currently being fielded, such as the submarine fleet’s RF Distribution and Control System (RFDACS) are proving to be large, complex, failure-prone, and difficult to maintain. RFDACS and other shipboard switching systems are based-upon COTS assemblies that are intended for standard industrial use. At the core of the problems are the inherent physical properties of electro-mechanical switches.

New switching technology is needed to implement high-reliability, low-loss, medium-power, RF switching within an integrated architecture that avoids the logistical issues of external cables and connectors. COTS products intended for industrial environments are unlikely to address the special challenges of the military environment, such as a wide range of operational temperatures, limited means of heat dissipation, high shock levels, and condensing humidity conditions.

New switching technology, such as Micro-Electromechanical Machine System (MEMS) and GaAs switching, has the potential to enable very low loss/high reliability switching in a compact matrix "backplane" (such as microstrip.) (In addition, the same technology could be used to build high-reliability automated antenna matching networks.) Although this switching technology has been under development for several years, it is not yet mature enough to utilize in a complex industrial or military system. In addition, it is not apparent that military environmental conditions are being addressed in current industry-funded development programs.

Other applications with real-estate limitations, challenging environmental requirements, and mission- critical reliability could also utilize this technology: small Unmanned Aerial Vehicles (UAVs), Unmanned Undersea Vehicles (UUVs), autonomous off-board sensor systems, man-portable communications suites, and surface and air platforms with multiple radio/antenna combinations.

This new technology should provide the desirable features of a conventional switching solution, but with higher reliability and a compact configuration. The system must be able to accommodate frequencies from DC through at least 3 GHz (21 GHz desirable) for all ports and provide switching between any two ports. The attenuation from any input to any output port should be as low as possible (maximum acceptable is 2 dB at 2 GHz.) A power handling capability of at least 50W (1 kW desirable) is required per RF path. The system must have a "failsafe" mode, which will maintain the current RF path in the event of power or computer failure. The architecture must allow the expansion to high-power switches and provide a means of interface with automated control circuitry. Power consumption and heat dissipation should be minimal when operated continuously.

PHASE I: Perform a trade-off study to determine the optimum switching technology (e.g., solid-state, electromagnetic, electro-optic, Micro-Electromechanical Machine System (MEMS), Micro-Mechanical Relay (MMR), microstrip, etc.), architecture, and serial bus control to implement an integrated RF switch matrix. Demonstrate feasibility of a transfer switch matrix design with 16 total ports (4 input ports, 4 transfer ports and 8 output ports) that duplicates the operation of 16 individual transfer switches in a 4x4 matrix. This design should meet the specified objectives.

PHASE II: Build and test the transfer switch matrix prototype module that was designed in Phase I. Demonstrate the performance of the prototype switch matrix according to the objectives listed above. Demonstrate controlling the switch positions using a standard serial bus protocol. Design a switch matrix with 12 input, 16 output, and 12 transfer ports using the design of Phase I and a standard serial bus control circuitry.

PHASE III: Build and test the switch matrix system designed in Phase II. Demonstrate that the design satisfies the objectives. Integrate the switch matrix assemblies into two RFDACS low-power switch matrix drawers, and perform system level environmental and operational testing that will validate the design.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This development will be applicable to a number of military applications as well as any commercial equipment requiring a large number of RF/microwave switches such as the telecommunications industry.

REFERENCES:

1. "MEMS Switch Technology Approaches the Ideal Switch," Tom Campbell, Applied Microwave & Wireless, v. 13, No. 5, May 2001, pp. 100-7.
2. "MEMS Animates Miniature RF Switch," Jack Browne, Microwaves & RF, v. 40, No. 11, Nov 2001, p. 104.

KEYWORDS: switch; matrix; RF; power; MEMS; PIN diode

N04-151 TITLE: Development of Advanced Thermal Protection Concepts for Extended Flight/Maneuvering Navy Strategic Reentry Bodies

TECHNOLOGY AREAS: Materials/Processes

ACQUISITION PROGRAM: Strategic Systems Programs

DESCRIPTION: New reentry bodies designed for extended and/or maneuvering flights will be required to meet aero- and thermodynamic demands not required of current reentry bodies. The new reentry environment is defined as: Peak Heat Flux: 4000 BTU/ft2-s, Peak Surface Pressure: 125 psi, Peak Surface Shear: 300 psi, Peak Temperature: 7500ºR. Current RB thermal protection systems may be inadequate for anticipated extended and/or maneuvering flight. There are no available materials that can maintain their integrity and continue to function in this sustained severe aerothermal environment. Therefore, new materials must be developed requiring research and development effort involving technical risk. This will require new, innovative approaches to solving this problem.

PHASE I: Develop a feasibility study, including a proposed thermal protection concept that will meet aerothermal, mechanical and ablative requirements, and a plan for a Phase II follow-on effort.

PHASE II: Fabricate a demonstration article of Phase I material design of sufficient size to support thermomechanical characterization and perform preliminary assessment. If material meets expectations, provide sufficient material to Government for thermomechanical characterization. Fabricate additional material billets to assure reproducibility and establish manufacturing baseline.

PHASE III: Finalize Phase II design in response to ground test results. Produce additional materials to support material characterization. Develop production processes and monitoring techniques necessary to assure material performance, minimizing variability, and maximizing reliability, in a cost-effective manner. Transition material for use in advanced extended/maneuverable flight strategic reentry system.

PRIVATE SECTOR COMMERCIAL POTENTIAL: Developed material (with modifications) could be applicable to commercial heat-treating applications as a thin-walled thermal barrier. Oxidation-resistant variation could have applications in high temperature motor systems, as well as other DoD or NASA reentry systems.

REFERENCES: There are no applicable published references. A package of additional information is available on request.

KEYWORDS: strategic; reentry; heatshield; composite; insulator; maneuverable

N04-152 TITLE: Nuclear Event Detection and Circumvention Controller

TECHNOLOGY AREAS: Sensors, Electronics, Battlespace

DESCRIPTION: One of the major requirements for the electronics used on board Fleet Ballistic Missile (FBM) weapon systems is the ability to function reliably after exposure to transient ionizing radiation caused by a nuclear event. At the transistor level, high transient gamma exposure will result in excessive hole-electron pair generation which at increasing levels of radiation will cause the electronics to upset, latchup (if pnpn paths and appropriate bias are present) and burnout. The common solution to this problem as used by the Navy over several generations is to provide system level detection of the nuclear event using discrete P-I-N diodes. The P-I-N diode signal is conditioned and then used to drive a controller, which interrupts the power to critical parts using power strobing functions. After the nuclear event, the system will have survived however a system reboot is needed to resume normal operation. Clearly, the speed at which normal operation resumes is critical to mission accuracy. Legacy electronics are being replaced which require a flexible circumvention architecture that supports multiple circumvention levels and distributed circumvention detection and control. So research and development is required to replace the obsolete electronics while maintaining the necessary accuracy. A new, creative or innovative approach to this problem is needed. The design should assume radiation exposure high enough to disrupt system operation and risk permanent damage (burnout) of the integrated circuits.

PHASE I: Conduct a feasibility study including innovative design concept(s) that provide a radiation hardened design capable of nuclear event detection and circumvention of critical electronics. Include a discussion of advantages as well as the challenges associated with your approach. Provide a detailed plan for phase II of the project.

PHASE II: Design a prototype of the circuit that will detect a nuclear event and protect critical electronics from damage as described above. Build a prototype and conduct a prototype demonstration to verify that the radiation hardened design functions properly. Provide all documentation and interface requirements that will be needed to incorporate the design methodology into subsystem and system level electronics.

PHASE III: Strategic Systems Programs will use the interface requirements included in the documentation package delivered at phase II, to design strategic level electronics. Furthermore, as new radiation hard design methods become available the small business may develop additional interface requirements.

PRIVATE SECTOR COMMERCIAL POTENTIAL: This capability would be useful in the commercial satellite, aerospace and defense industries, where there is a need for modern control, sequencing and interlock radiation hardened electronics. One example would be modern telecommunication satellites that use large-scale integrated circuits with nuclear event detection and circumvention. This capability will enable the use of commercial electronics data and design tools in the design of strategic level electronics.

Classified proposals are not accepted under the DoD SBIR program.

REFERENCES:

1. M.A. Rose -1984 IEEE NSRE Conference short course-'Radiation effects and hardened techniques'
2. G.L. Hash etal-1992 IEEE Radiation effects data workshop record
3. Dave Emily-1996 IEEE NSRE short course- 'Total Dose Response of Bipolar Microcircuits'
4. 2000 IEEE NSRE short course 'Radiation test challenges for the new millennium'
5. 2001 IEEE NSRE short course 'Radiation effects in advanced microelectronics' July 16, 2001
6. 2002 IEEE Radiation data workshop- July 15, 2002

KEYWORDS: Nuclear event detection; circumvention; radiation; Electronic Design Automation (EDA); reliability; Single Events Effects (SEE)